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Team Product Document

GO Number	S/A Number	Page 1 of 59	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	32120		59	New	EID-08640

Program Title
Closure of ETEC (R21-RF)

Document Title
Building 4059 (SGPTF) Decontamination and Decommissioning Final Report

Document Type
Engineering Information Document

Related Documents

Original Issue Date: 05-02-2005

Release Date: RELEASE 05-02-05 CV

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IR&D Program? Yes ☐ No ☒
If Yes, Enter Authorization No.

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Abstract

The former SNAP Ground Prototype Test Facility (SGPTF), designated as Building 4059, located at Boeing Canoga Park's Santa Susana Field Laboratory in Ventura County, California, operated under Department of Energy funding from 1963 until 1969. It was used to test a SNAP nuclear reactor having a maximum thermal power output of one megawatt under simulated space environmental conditions for duration of one year. Various decontamination and decommissioning (D&D) activities were conducted in phases, starting in 1970. In addition, a non-nuclear sodium test system (LLTR) was installed and operated in the facility during the late 1970's and 1980's. This report provides a summary of the SGPTF and LLTR decontamination and dismantlement activities. It includes a description of the facility, an overview of the D&D program, details and highlights of the program activities, waste management and cost summaries, and a synopsis of lessons learned from the program.

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1.0 INTRODUCTION

Building 059, designated as the SNAP Ground Prototype Test Facility (SGPTF) is one of a number of former nuclear test facilities that has been decontaminated and decommissioned at the Santa Susana Field Laboratory (SSFL). The SGPTF has been completely dismantled with all components and materials removed. This report documents the decontamination and dismantlement activities performed at the facility, which occurred over the time period of 1970 through 2004. Building 059 has more recently been referred to as Building 4059 to designate that it is located in Area 4 of the SSFL.

1.1 FACILITY LOCATION

The SGPTF was part of Rocketdyne's Santa Susana Field Laboratory in the Simi Hills of southeastern Ventura County, California, adjacent to the Los Angeles County line and approximately 29 miles northwest of downtown Los Angeles. Figure 1.1.1 shows the location of the SSFL relative to the surrounding communities. The SGPTF was located in Area IV, which comprises the western portion of the SSFL in an area known as Burro Flats. This is indicated in Figure 1.1.2, a portion of the 1967 edition of the U.S. Geological Survey Calabasas Quadrangle topographic map. Figure 1.1.3 is an aerial photograph of Area IV, showing the SGPTF and surrounding buildings.

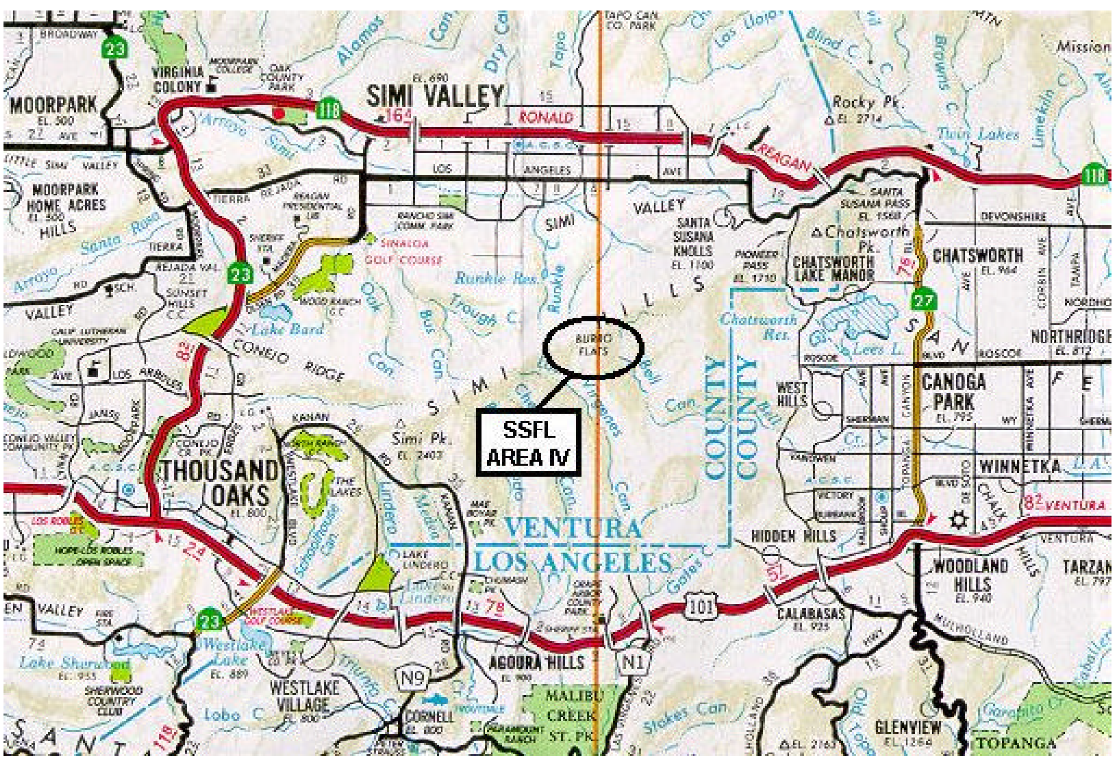


Figure 1.1.1. Map of Southeastern Ventura County, Showing the Location of the SSFL.

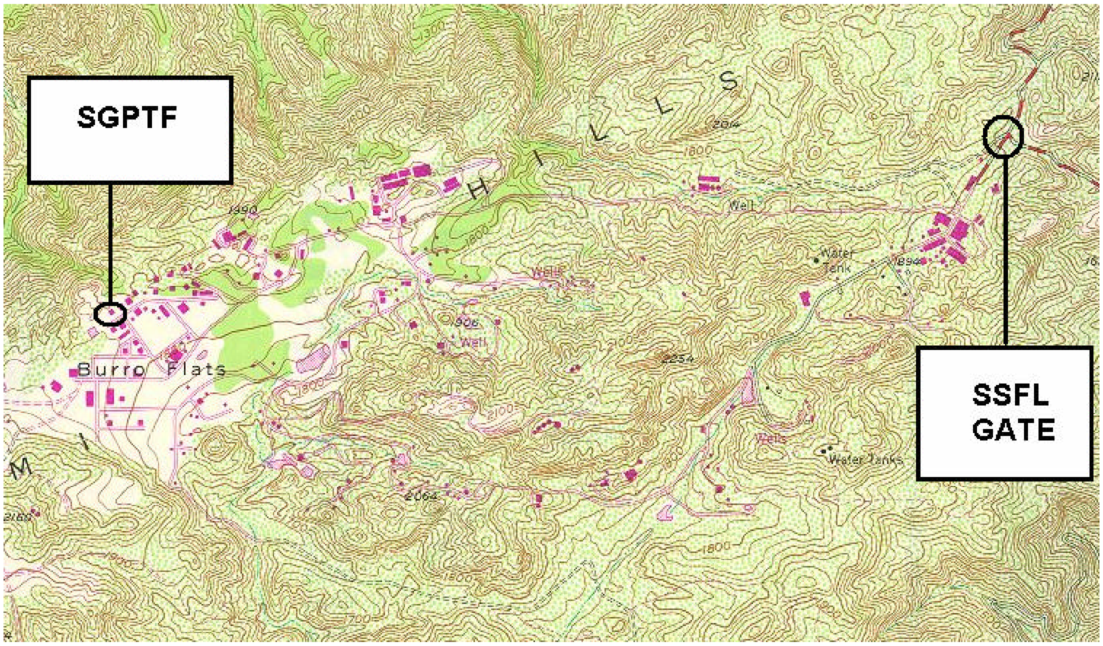


Figure 1.1.2. Topographic Map for the Area Encompassing the SSFL, Showing the Location of the SGPTF.

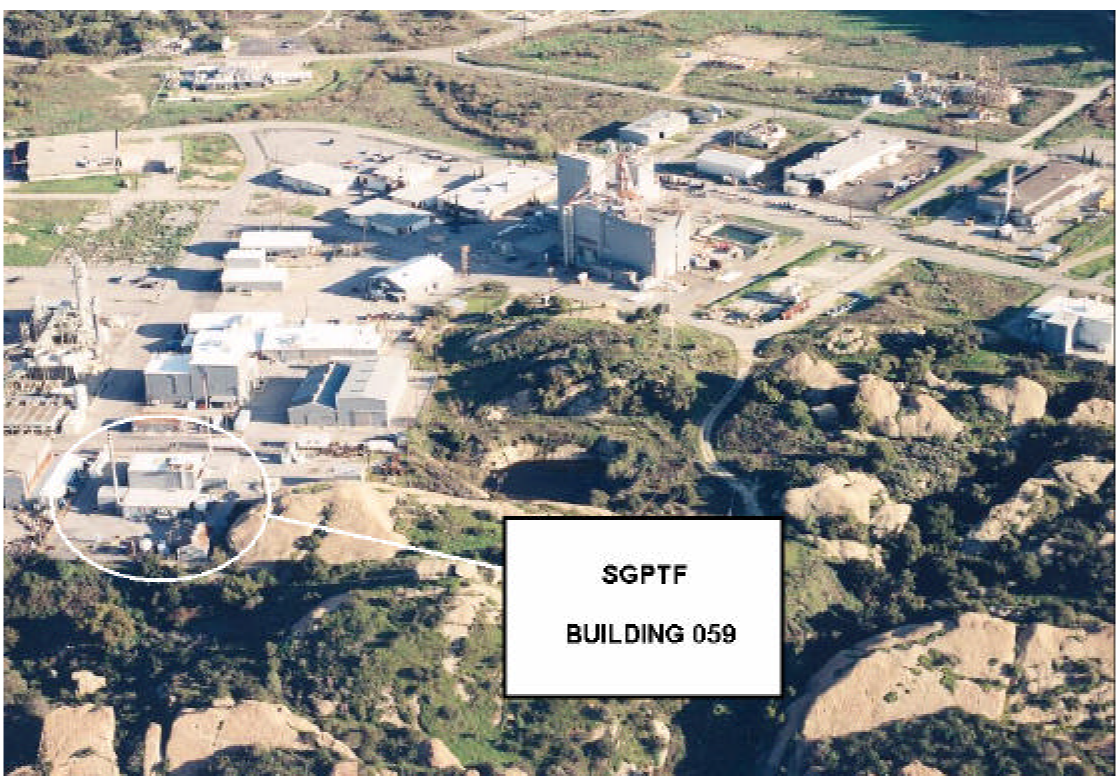


Figure 1.1.3. South Facing Aerial Photograph of SSFL Area IV.

1.2 BACKGROUND:

The Systems for Nuclear Auxiliary Power (SNAP) programs were a series of research and development projects on compact nuclear power sources for use as auxiliary power units for terrestrial, underwater, space, satellite, and other specialized applications. The SNAP programs were initiated in the mid-1950s as joint efforts of the Atomic Energy Commission (AEC) with the Army, Navy, and Air Force, and the National Aeronautics and Space Administration (NASA). The development of systems utilizing reactors as the energy source carried even-numbered designations (SNAP-2, -4, -6, -8 and -10), while odd-numbered designations were reserved for fission product and isotope heat source devices. The SSFL SNAP Program supported testing of several SNAP projects.

The reactor test program was performed for the AEC by Atomics-International (AI), a former division of Rockwell International, on government-optioned land at the Rockwell International Santa Susana Field Laboratory (SSFL) in the Simi Hills of Ventura County California, northwest of Los Angeles. Building 059 was one of the facilities supporting this program. In 1966, portions of the SSFL (including Building 059) were used by the AEC to establish the Liquid Metal Engineering Center (LMEC). In 1978, the name of this center became the Energy Technology Engineering Center (ETEC), in view of its broadened scope and expertise in a variety of energy technologies.

1.3 FACILITY DESCRIPTION

The SGPTF was designed and constructed to test a SNAP nuclear reactor and modified shortly after initial construction was completed. The facility featured a underground "shielded controlled atmosphere vault" and included the following access areas: a high bay vault access and secondary equipment area, a general support and operating area, mechanical and electrical support area, a pump room and a vacuum equipment room. The high bay area was flanked by two attached low bay structures containing the control room and office area on the south and electrical, mechanical equipment and support areas on the north. A photo showing the above grade structure from the east is shown in Figure 1.3.1.

The SNAP operational test required maintaining the vault atmosphere temperature, pressure, and oxygen concentration within the given allowable limits. Interior support systems provided for the removal of heat generated from the reactor, the maintenance of relative vacuum conditions and for the containment of contaminated particles and radioactive gases. Two stairwells provided personnel access. Support systems such as cooling towers and fission gas collection tanks were located outside in the yard to the north.

Construction of Building 059 started in July 1961 and was completed in May, 1963. During 1964 and 1965, the building was modified to rebuild the north test cell and to construct an underground concrete addition attached to the original building structure. Figures 1.3.2 and 1.3.3 present photos taken during construction of the addition in 1964. The final configuration of the building is represented in the conceptual drawing Figure 1.3.4. Plan and elevation views of the test vault, test cells, and the west addition are shown in Figures 1.3.5 and 1.3.6, respectively. The addition floors, ceilings and the three outside walls are formed of 2-foot thick steel-reinforced ordinary concrete. The fourth, inside (east) wall consisted of the 3-1/2 foot thick original building west wall. The addition was constructed to house a larger vacuum system for improved simulation of space environment in the test cell.

The test vault, approximately 28 ft wide by 40 ft long and 36 ft deep, contained two test cells (north and south) located below the west end of the test vault floor, The test cell structural concrete extended down to 55-feet below grade. The north test cell, shown in Figure 1.3.7, was lined with 1/4-inch steel plate and hermetically sealed doors to maintain vacuum conditions during test. The test cell walls and floor behind the liner were formed of steel-reinforced ordinary concrete with 1% boron added to the mix. The north test cell contained the vacuum vessel, exposed in-cell coolant piping and instrumentation, a cast-in-place water-cooled concrete shield between the vacuum vessel and the cell liner, and overhead removable concrete shield blocks with a stainless steel block support structure. The south test cell was not used for the SNAP test program.

The Vacuum Equipment Room (VER) contained two 50,000 liter/second ion vacuum pumps; two large roughing pumps; two 48-inch pneumatically operated, high vacuum isolation valves; two liquid nitrogen-cooled cold trap/cold plates and the associated support hardware. The Pipe Chase Room (PCR), located immediately beneath the VER, contained the horizontal section of the 60-inch diameter stainless steel vacuum duct running from the VER to the north test cell reactor containment vacuum vessel (Refer to Figure 1.3.5). Prior to reactor operations, the PCR was filled with sand to serve as radiation shielding around the vacuum duct.

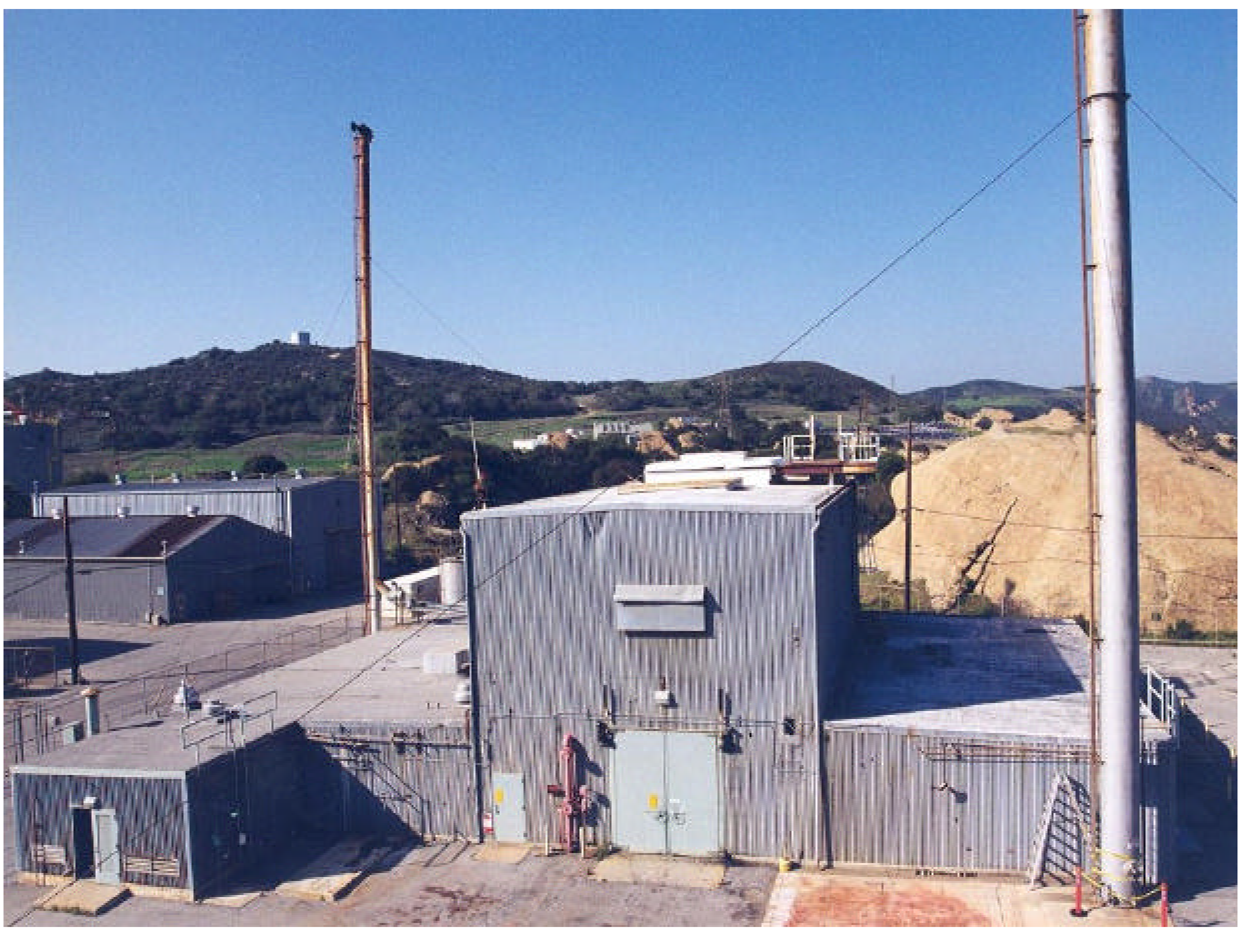


Figure 1.3.1. Photograph (facing west) of Above Grade SGPTF in 1999

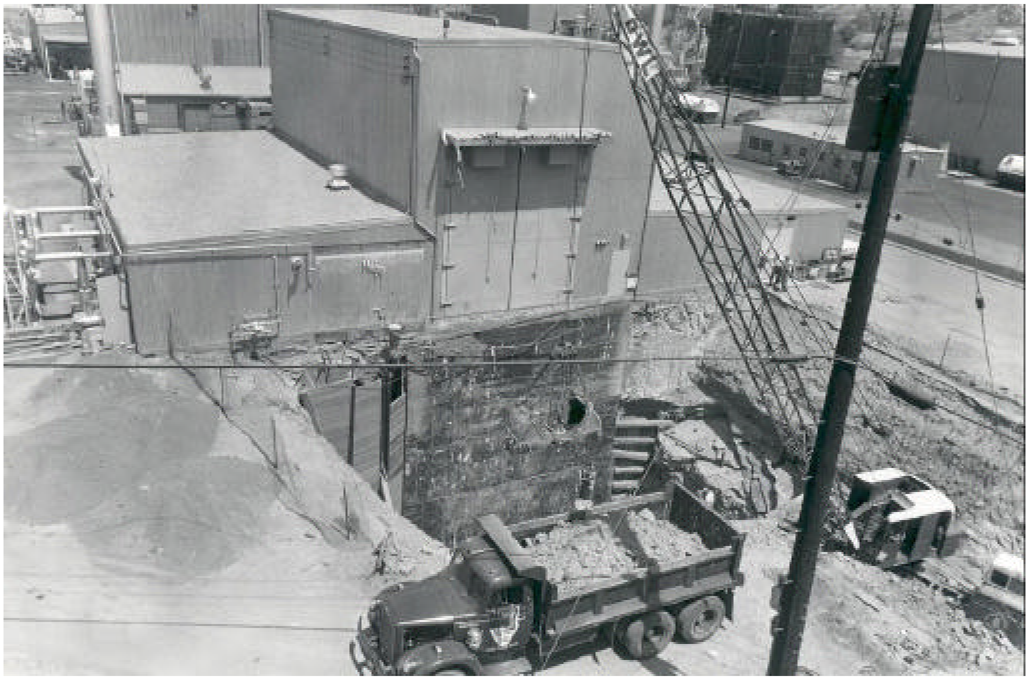


Figure 1.3.2. Excavation for the West Addition in 1964

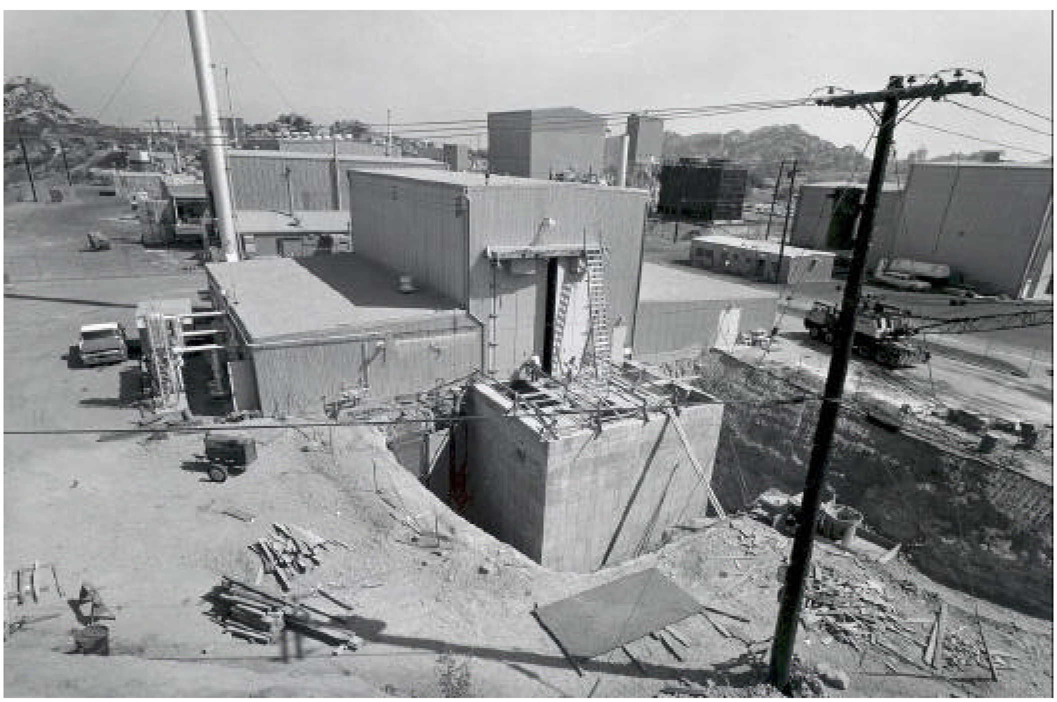


Figure 1.3.3. West Addition Concrete Near Completion in 1964

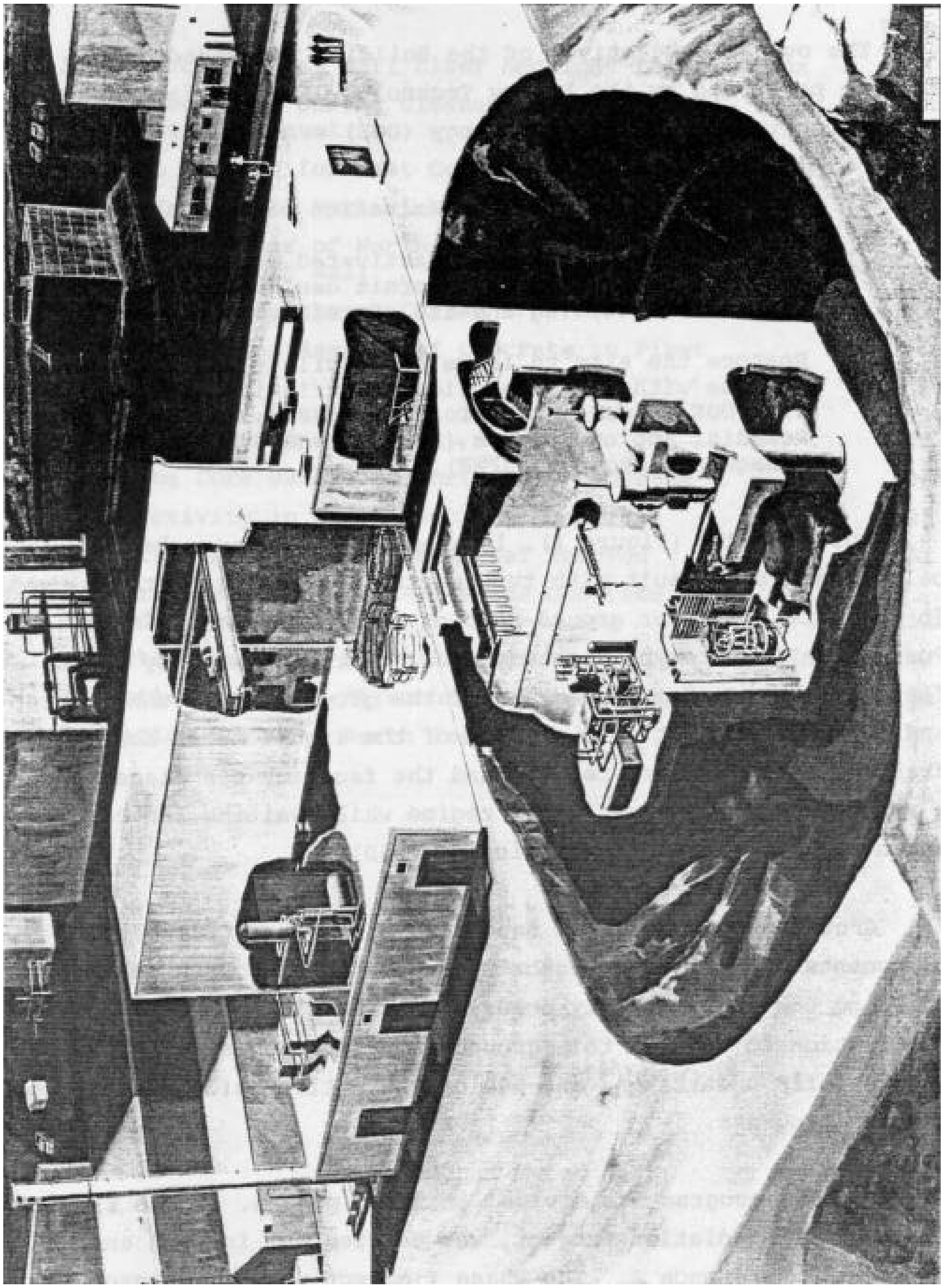


Figure 1.3.4. Conceptual Drawing of Final SGPTF Configuration

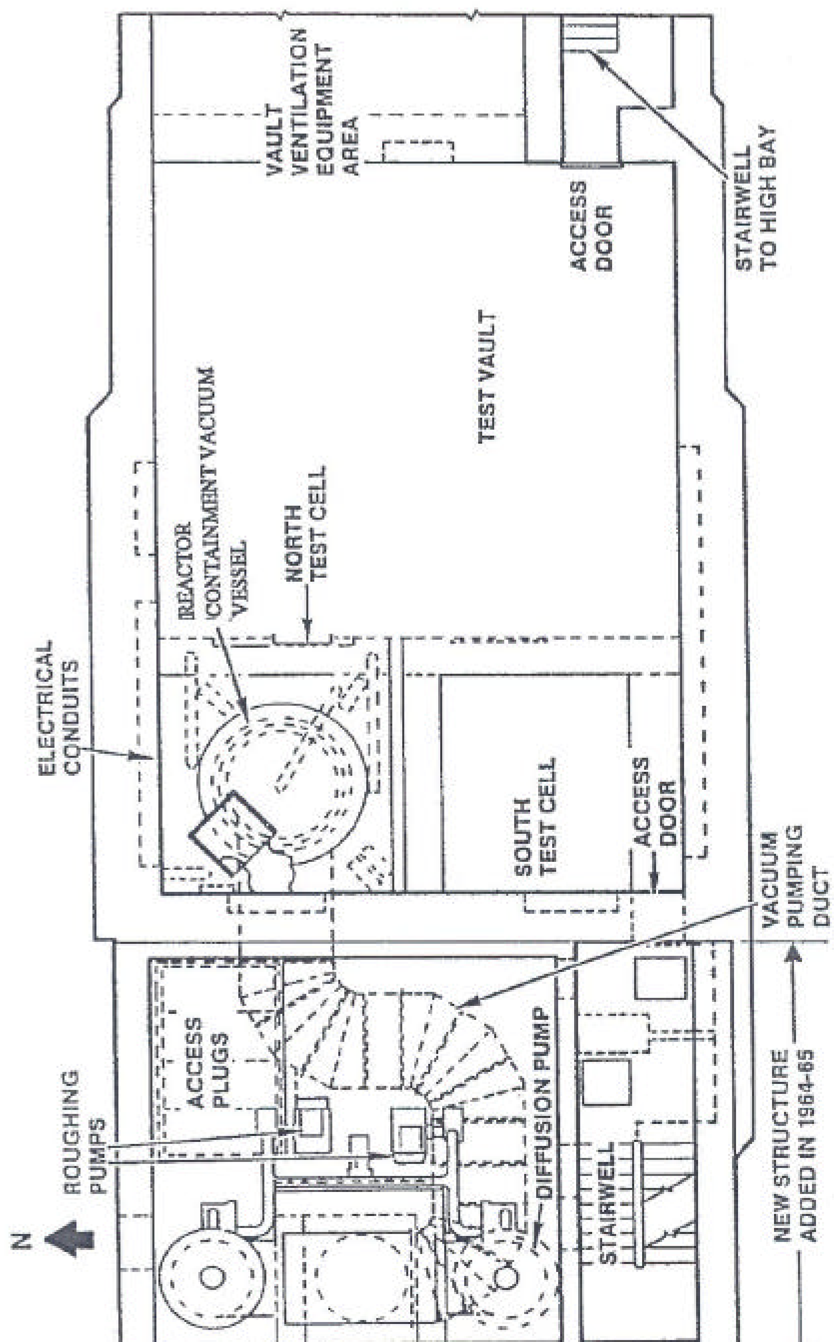


Figure 1.3.5. Plan View of PCR Level Configuration

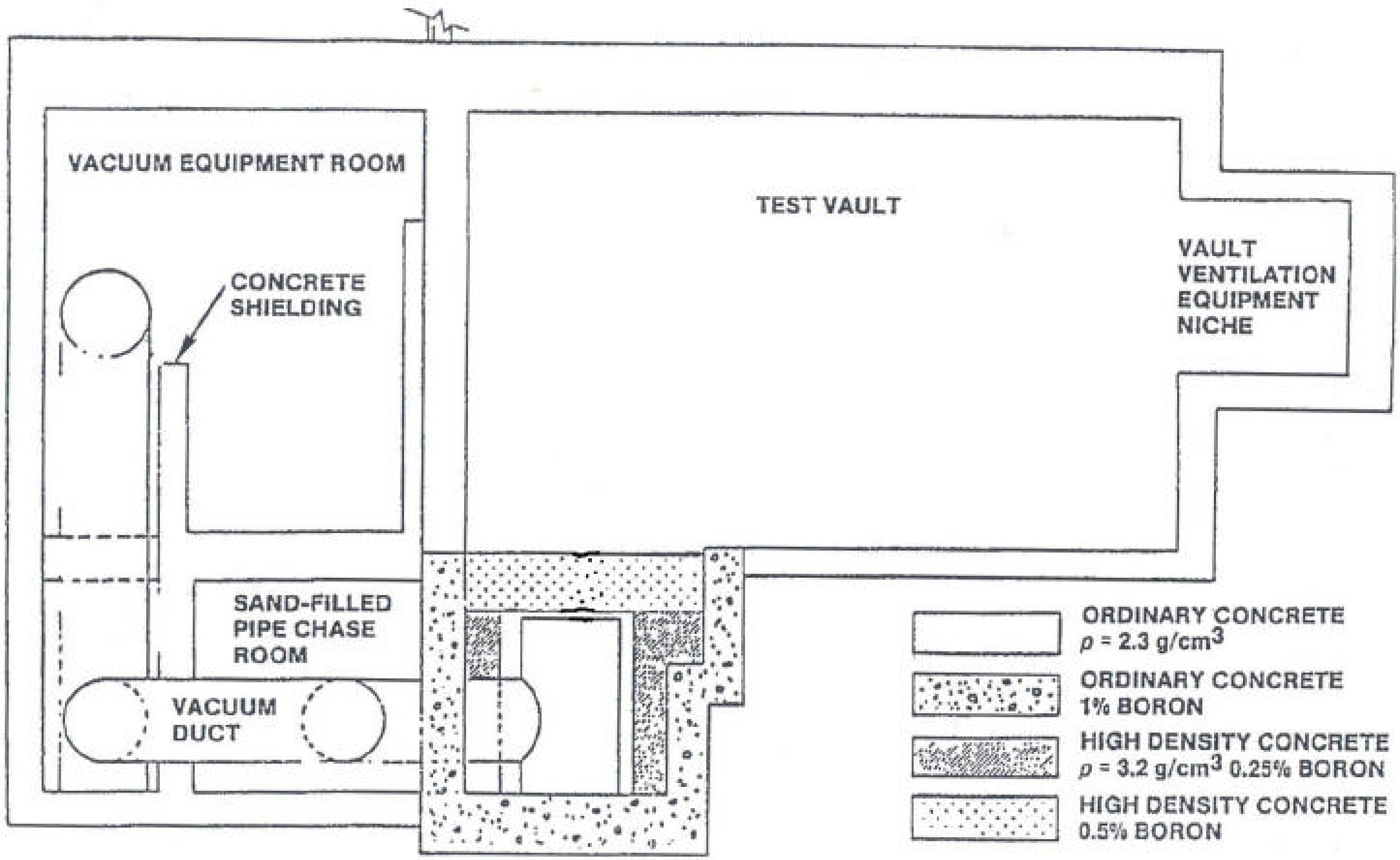


Figure 1.3.6 Elevation View of Below Grade Vault, Test Cell, and West Addition

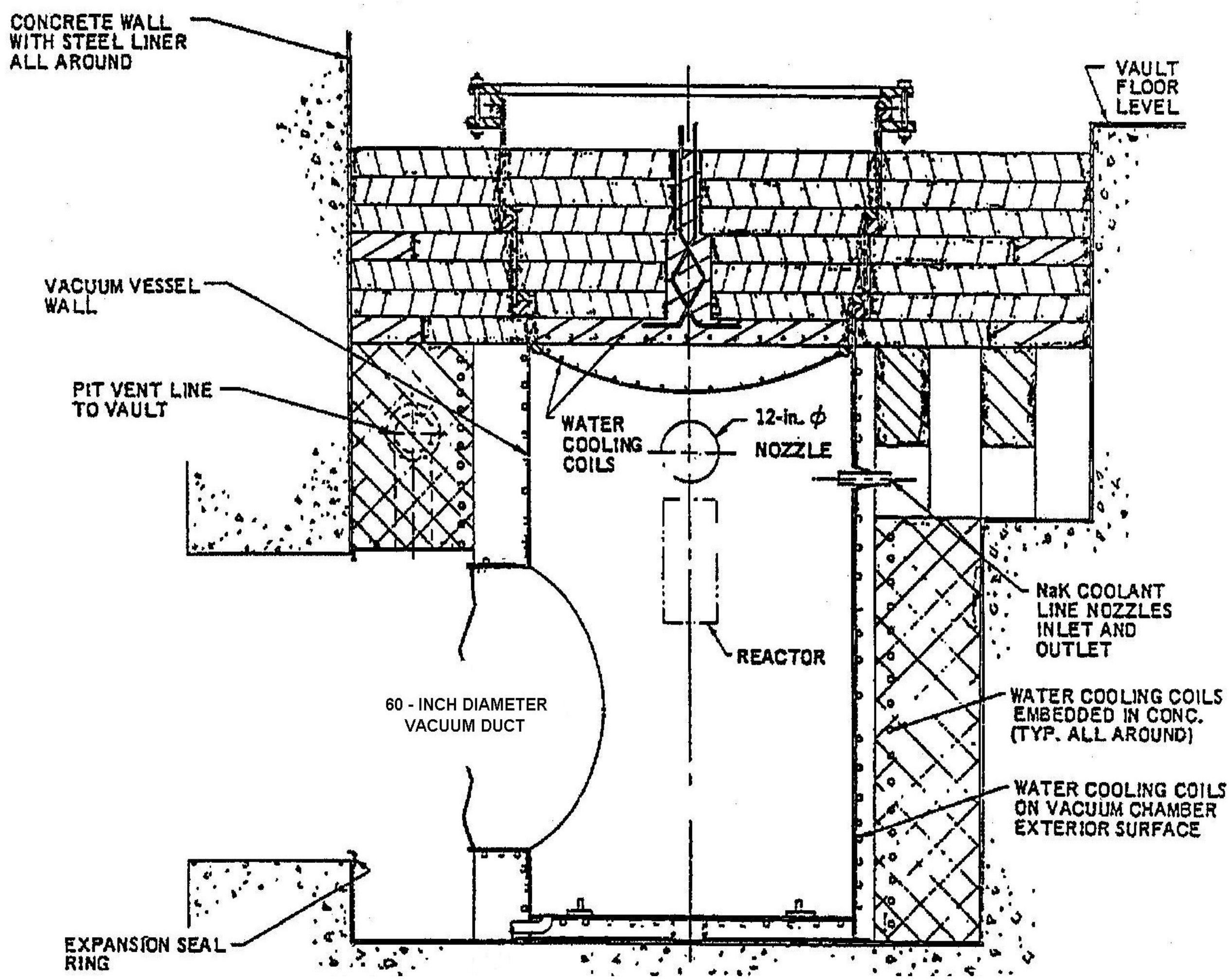


Figure 1.3.7. Elevation View of North Test Cell

1.4 OPERATIONAL HISTORY

From June 1968 through December 1969 the SGPTF hosted the operational testing of the SNAP 8 Development Reactor (S8DR). The S8DR used a hydrated zirconium-uranium alloy as a fuel and liquid sodium-potassium (NaK) alloy as a coolant. The reactor (including operational hardware) measured 29 by 31.3 inches, had a maximum power level of 1 MWt. The S8DR was the last reactor to be tested under the SNAP reactor program.

The S8DR test consisted of checkout and long-term operation of the reactor system without the power conversion system attached. An air blast dump heat exchanger was used to dissipate the reactor heat. The test was designed to accomplish the following objectives:

1. Development of the SNAP-8 automatic start-up and temperature control systems for long-term operation.
2. Demonstration of 12,000 hours of uninterrupted automatic operation.
3. Operation of an integrated flight-configured SNAP-8 control and reflector assembly.
4. Endurance operation with 600 kwt output at 1300 degrees F and with 1000 kwt output at 1000 degrees F.

Early SGPTF nonnuclear tests were run until late 1964, when the facility was shut down for building and test cell modifications. The reactor system and coolant loops were installed during 1967 and early 1968. By June 1969, the prototype SNAP-8 reactor and flight-type shadow shield were operating under vacuum conditions in the rebuilt north test cell. This test was shut down in late 1969, after 7500 hours of continuous operation. All major technical objectives except for the 12,000 hour endurance run had been achieved.

Final post-test criticality checks were run in January 1970. Later in that year, after cool down to near ambient temperatures, the reactor (i.e., fueled core and vessel, reflectors, controls, instrumentation, and structure), the shadow shield, and the associated in-cell sodium/potassium coolant system pipes were removed and dispositioned. The reactor core was disassembled at the SSFL Building 20 Hot Lab where it was found that 72 of the 211 fuel elements had cracked cladding tubes. It was believed the fuel element cladding ruptures were a result of excessive strain caused by fuel swelling. Further information about the SNAP program including the S8DR reactor and test is available in Reference 1.

Following the removal of the S8DR, the north test cell was sealed and the associated vacuum systems, chilled water systems, gas compressors, and waste collection tanks mothballed. In 1973, all reactor control consoles, reactor instrumentation, remote handling equipment; and remaining NaK primary and secondary loop piping and equipment were dismantled and removed, and Building 059 was placed on inactive status. The radioactivity remaining at the building was confined to the remaining test equipment and activated facility test cells.

The below-grade test vault at Building 059 was found to be a suitable location to conduct a non-nuclear test program. The ETEC erected the Large Leak Test Rig (LLTR) in the unused south test cell, the test vault and the high bay areas. This program's purpose was to investigate the effects of sodium/water reaction events that could occur in Liquid Metal Reactor (LMR) steam generators. Nonradiological testing of sodium-water reactions were performed in the LLTR from the mid-1970's until 1982.

2.0 D AND D HISTORICAL SUMMARY

2.1 DECOMMISSIONING OVERVIEW

After S8DR operations were completed in 1969, the reactor was removed for post test examination. In addition, systems having potential safety or contamination issues were either removed or drained and sealed as best management practices. The facility was then placed in a surveillance and maintenance mode to allow radioactive isotopes such as Cobalt -60 (Co^{60}) to decay. Letting the radiation field decay allows safer, easier and less costly D&D operations in the future. (Co^{60} has a half life of 5.28 years) Parts of the S8DR system or materials and components that were not irradiated during the testing were periodically removed and sent to disposal. However, the PCR and the north test cell remained highly radioactive and no plans to proceed with additional D&D operations were envisioned until 1987.

In the early years following the removal of the S8DR, options for the final end state were discussed. The alternatives considered were entombment, mothballing and continued surveillance and maintenance, or complete removal and disposal of the facility. Ultimately, the decision was made to remove the entire facility. Due to the nature of work at the site, the availability of expertise in remote handling operations, experienced nuclear workers and suitable company equipment and resources made the interim D&D of Building 059 feasible.

Groundwater intrusion into the facility was first discovered in 1983. A plan to investigate and resolve the groundwater problem was prepared by ETEC and approved by the DOE. The following sections summarize the history of the decommissioning work performed at the SGPTF.

2.2 EARLY POST OPERATIONAL PERIOD

A partial post test dismantlement effort began in June 1978 and continued through September 1978. Major accomplishments were the removal of all radioactively contaminated or activated tanks, piping and equipment from the ground level equipment room areas; removal of buried external radioactive liquid and gas waste holdup tanks; removal of all test vacuum equipment components in the VER; partial removal of the 60-inch diameter vacuum duct from the VER-PCR chimney area; and removal of some of the shielding sand from the PCR. Following this work, activities were terminated and the rooms sealed. Ensuing surveillance activities were limited to annual inspection and radiological survey of the area. Several forms of activated materials remained in the facility: stainless steel, ordinary sand, mild steel plate, steel reinforcing bars, high density shielding concrete, and both ordinary and borated structural concrete.

Continued maintenance and surveillance activities between 1978 and 1982 showed no significant findings. During the period 1983-1986, however, ground water intrusion into the PCR and south test cell was observed. Ground water presence inside the building was first observed in the open south test cell during a routine facility inspection in 1983. Investigations were undertaken to determine the nature and extent of this intrusion. This included installation of a 2-inch observation hole through the cover seal and removable concrete shielding blocks above the north test cell. No water was observed in the north test cell in 1983. However, the water in the PCR level was 10.5 feet deep.

A plan of action was developed to process the estimated 30,000 to 40,000 gallons of contaminated water accumulated in the PCR. The south reactor test cell was cleaned up while an ion exchange column was fabricated and installed in the VER immediately above the water-filled PCR. In the interim, contaminated water was pumped from the PCR and transferred to the Radioactive Materials Handling Facility (RMHF) for processing in the facility radioactive liquid evaporation system. Since the evaporator processing capacity was only 100 -200 gallons per day, the ion exchange column was also needed because of the large volume of water to be processed. Additional activities conducted during this period included the ordering of equipment and developing of facilities to enable groundwater to be pumped from around the building structure and to obtain capability to store 20,000 gal of contaminated water in the event of a sudden influx of groundwater into the PCR.

During the period of September through November 1983, almost 50,000 gal of contaminated water were removed from the PCR and processed to remove the radioactivity. From late 1983 to 1987, water was also pumped from the outside of the facility foundation through the French drain ground water removal system installed with the new addition in 1964. The ground water level was monitored and controlled so as to maintain a small positive hydraulic head on the outside of the facility. This measure was intended to keep any water movement from outside to inside to keep any radioactive constituents within the facility.

During routine surveillance activities in April and May 1987, audible fluid and solid particulate movement noises were heard behind the south test cell liner. These observations had not been noticed during previous surveillance activities. The observation port in the north test cell cover seal was subsequently reopened for inspection and water was observed on the floor. The inspection revealed a north test cell floor water depth of approximately 3 inches. Water grab samples idicated contamination with the radioactive isotopes Co-60, Eu-152, and Na-22. The concentrations of both the Eu-152 and Na-22 were above their release values. It was concluded that the north test cell had been breached by ground water infiltration and, therefore, that the changing water pathways in and around the PCR and test cells could possibly lead to environmental contamination outside the facility.

These findings were immediately reported to the DOE. These issues led to funding being made available for initiation of the Building 059 Remediation Program early in 1988.

2.3 PIPE CHASE ROOM REMEDIATION (PHASE I)

The technical goal of the PCR remediation project was to identify and seal the source of the local groundwater intrusion into the radiologically contaminated Building 059. The objective was to prevent possible radiological contamination to the environment from the groundwater being in constant physical contact with the radioactive structural materials of the facility. The structure contained neutron-activation products within in the concrete and structural steel plus the stainless steel vacuum ducting and shielding sand from the testing performed in the 1960s. To achieve the objective of the Pipe Chase Room Remediation, the 20' by 22' by 12 feet high room would have to be emptied of contents.

The contents of the PCR were the shielding sand and the 5-foot diameter stainless steel vacuum duct that 'snaked' from the VER above the PCR to the west side of the vacuum vessel that previously contained the S8DR test reactor. Figure 2.3.1 is a plan view of the duct location within the PCR. Figures 2.3.2 and 2.3.3 show conditions early in the PCR Remediation Project. The contact radiation readings of the duct immediately outside of the test cell were 5R/hour. Radiation levels decreased rapidly with distance from the test cell and particularly after the first 90 degree bend in the duct (Refer to Figure 2.3.1). The radiation levels near the test cell dictated remote methods and/or use of distance and shielding to minimize worker exposure. Much of the sand immediately around the duct nearest to the test cell was removed using a long pole attached to a vacuum nozzle as shown in Figure 2.3.4 and 2.3.5. The workers were able to work from at a distance and minimize exposure during this phase of sand removal. As soon as enough sand was removed to expose the irradiated vacuum duct, a torch attached to a long pole was used to segment the duct and remove much of the source of the high radiation field. The setup for torch cutting of the duct is illustrated in the mockup practice setup shown in Figure 2.3.6. Once enough sections of duct had been removed remotely, and the shielding block (Refer again to Figure 2.3.1) had been installed to reduce the exposure from the test cell components, personnel were able to enter the PCR to perform more efficient sand removal and to install and operate the remote cutting fixture to segment the remainder of the vacuum duct. Figures 2.3.7 and 2.3.8 illustrate the remote cutting device for the ducting.

Once all of the sand and vacuum duct components had been removed from the PCR, the path of the water intrusion was found to be the joint between the original facility outside wall and the PCR floor added as part of the new addition in 1964. A commercially available sealant was used on the leaking interface and effectively stopped water from entering at that location. A water management program was instituted to minimize the driving force outside the facility by lowering the outside levels of groundwater using the French well drain standpipe located on the northwest corner of the PCR floor. Unfortunately, this standpipe did not extend all of the way down to the lowest level of the concrete surrounding the test cell. The ground water levels could therefore not be lowered enough to prevent portions of the activated structural materials of the test cell floor from constant immersion in ground water.

The PCR remediation technical objectives were accomplished. Over 30 linear feet of 5-foot diameter, 3/8 inch thick, irradiated stainless steel ducting had been segmented, packaged and sent to land burial at the Hanford disposal site. Over 100 tons of activated sand had been removed, packaged and sent to disposal. A total of 4,562 cubic feet of low specific activity waste was sent to the Hanford site. The water intrusion pathway into the PCR had been located and sealed. However, there still remained possible environmental contamination issues because groundwater was still permeating the activated concrete floor of the reactor test cell. More details of the PCR Remediation Project can be found in Reference 2.

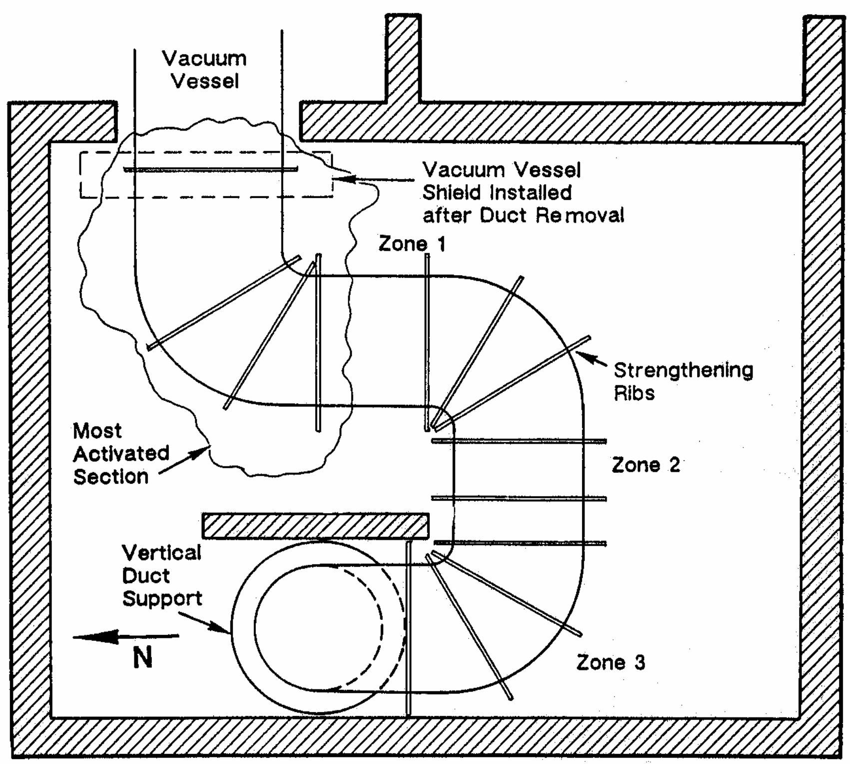


Figure 2.31. Plan View of PCR Configuration

Figure 2.3.2. View of PCR Looking East at Test Cell Location

Figure 2.3.3. View of PCR Looking South
(Note drum and lead shielding from 1978 D&D operations)

Figure 2.3.4 Worker Using Pole to Guide Vacuum Pickup

Figure 2.3.5 View of Vacuum Collection Drum and PCR Sand Below

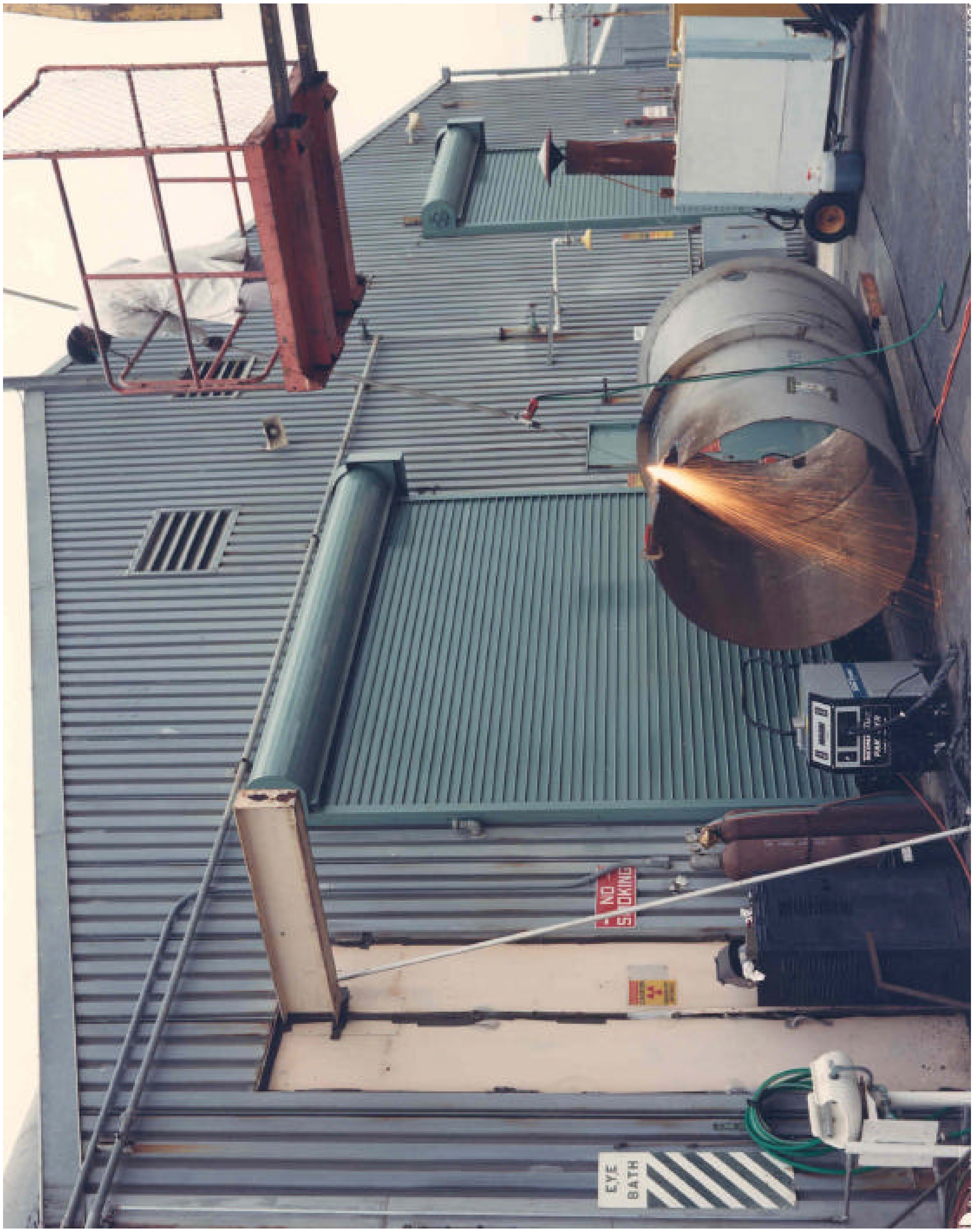


Figure 2.3.6 Remote Hand Torch Mockup for Operator Training

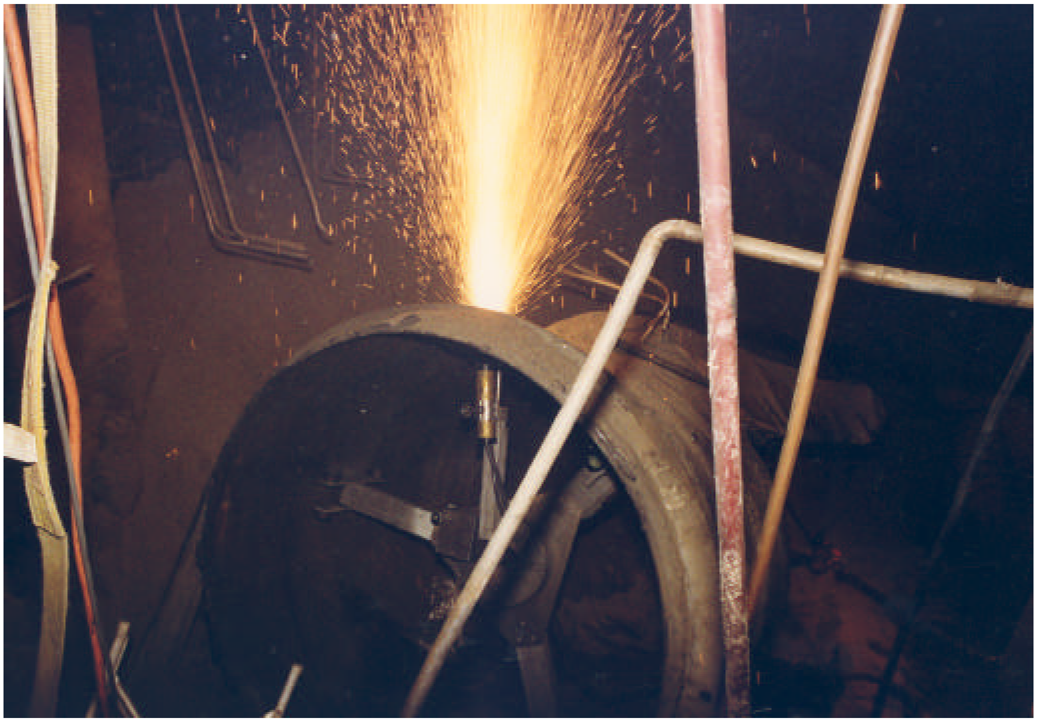


Figure 2.3.7 Segmenting SS Duct with Remotely Operated Cutting Device

Figure 2.3.8 Duct Cutting Device Operators Behind Shielding Wall in PCR

2.4 NORTH TEST CELL REMEDIATION (PHASE II)

The planned purpose of the test cell remediation program was to remove residual radioactive materials from the facility to meet the measurable activity guidelines established for accessible locations and to eventually release the facility for unrestricted use. A report covering the north test cell remediation in much greater detail is listed Reference 3.

Phase II was divided into two parts, designated as Phase IIA and Phase IIB. Phase IIA included (1) preparation of program documentation; (2) demolition equipment-process trade studies;(3) design, fabrication or procurement, development and installation of required equipment and tooling; (4) remote removal of the north test cell vacuum vessel, exposed conduit and piping, shielding concrete and cell steel liner; (5) disposal of all waste materials generated; (6) cleanup and radiological survey of the test cell; and (7) characterization of the facility to establish the Phase IIB starting point and requirements. The planning for Phase IIA activities began in February, 1989. After a readiness review, removal; of the vacuum vessel started in October, 1989. At the completion of Phase IIA by September, 1992, the test cell had been cleaned of loose waste, rubble, tools, and equipment. Small quantities of the liner and liner attachment pin material were still in place on the cell wall and at the floor/wall corners. This material could be more safely and easily removed during Phase IIB operations. The backhoe arm had been inspected, reconditioned, reinstalled, and operationally checked prior to initiation of Phase IIB work.

Phase IIB activities included structural analyses and definition of the necessary building structural reinforcement at the site for Building 059 contaminated structural material removal; removal of all remaining activated and/or contaminated building structural material, decontamination of the south test cell and other building areas as required; and final cleanup, independent radiological survey, and minimal restoration of the building to meet code or safety regulations.

Phase IIB D&D activities began in November 1992 and continued through January 1995, although only minor activities were done after December 1993. Phase IIB activities consisted of removing neutron activated structural concrete and rebar from the north test cell walls and decontamination of the south test cell by removing the cell lining, contaminated structural concrete, and removing surface contamination on the reaction product tank located in the adjoining south test cell. Phase IIB was an extension of Phase IIA activities using the same equipment and procedures. The activities involved in the effort were the following:

a. The south structural wall of the north test cell consisted of concrete and a layer of lead bricks for shielding. The concrete and lead were removed, leaving the south test cell quarter inch plate steel liner as the only barrier between the two test cells.

b. The west wall of the north test cell was removed except for a 2-foot-thick beam of concrete that was retained over the opening for structural support of the VER floor.

c. Structural concrete and the first layer of rebar were removed from the north and east walls of the north test cell.

d. Radioactive surface contamination (from water in-leakage) was removed from the south test cell by removing the cell liner and some surface concrete. Additionally, the RPT insulation and surface metal required decontamination and/or disposal.

e. Materials removed from the test cells were packaged and shipped for burial as low-level radioactive waste.

To support completion of these objectives, ETEC prepared all necessary work plans, procedures, instructions, schedules, progress tracking documents, and other forms or documents requiring DOE approval. ETEC provided (or purchased) all labor, equipment and materials, supervision and services required to perform this D&D work.

2.4.1 Planning and Technical Approach

The Phase II effort started early in 1989 and led to generation of an ETEC draft action description memorandum (ADM) for DOE approval of the Reactor Test Cell Remediation Project. Following approval, a Project Management Plan was developed and detailed engineering studies and design were initiated.

The planning approach emphasized: (1) making maximum use of experience and technology available at SSFL, (2) utilizing information available from literature search and external sources, emphasizing proven designs and processes for D&D; and (3) testing the selected equipment and systems to establish the Building 059 operating set points and limits by mockup testing in an uncontaminated environment prior to equipment installation for use in the radiologically restrictive test cell environment.

Three major types of radioactive material were identified for removal in early planning: the stainless steel test cell vacuum vessel, concrete (both the cast-in-place concrete shield and structural concrete), and the mild steel test cell lining. Planning, engineering, design, development, and mockup testing of the equipment and processes were handled separately for removal of each of these material types.

2.4.2 Vacuum Vessel Cutting and Removal

Adaptation of an existing company owned, remotely controlled, overhead mounted, vertical telescoping polar manipulator, previously used for commercial reactor in-service inspections (ISI), was chosen for the vacuum vessel removal task. It was outfitted with a remotely actuated plasma-arc cutting torch, positioning readout and remote camera viewing equipment. Supporting equipment for this task included special J-hooks for securing and removing pieces cut from the vessel, an orbital jib crane hoist for off-loading the cut vessel pieces into a waste transfer box, and a waste transfer system consisting of a powered, remotely controlled, commercial conveyor track and the waste materia1 transfer box. The conveyor system was positioned in the PCR for removing the cut vessel pieces from the test cell to the waste transport boxes positioned in the VER, directly above the PCR. Phase IIA D&D activities began in August 1989 and continued through September 1992. They consisted of removing materials within the north test cell to expose the structural concrete walls and floor.

An artist's conceptual layout of the vessel removal activity is shown in Figure 2.4.2.1. Figures 2.4.2.2 through 2.4.2.5 show key equipment and processes used to complete the vacuum vessel removal.

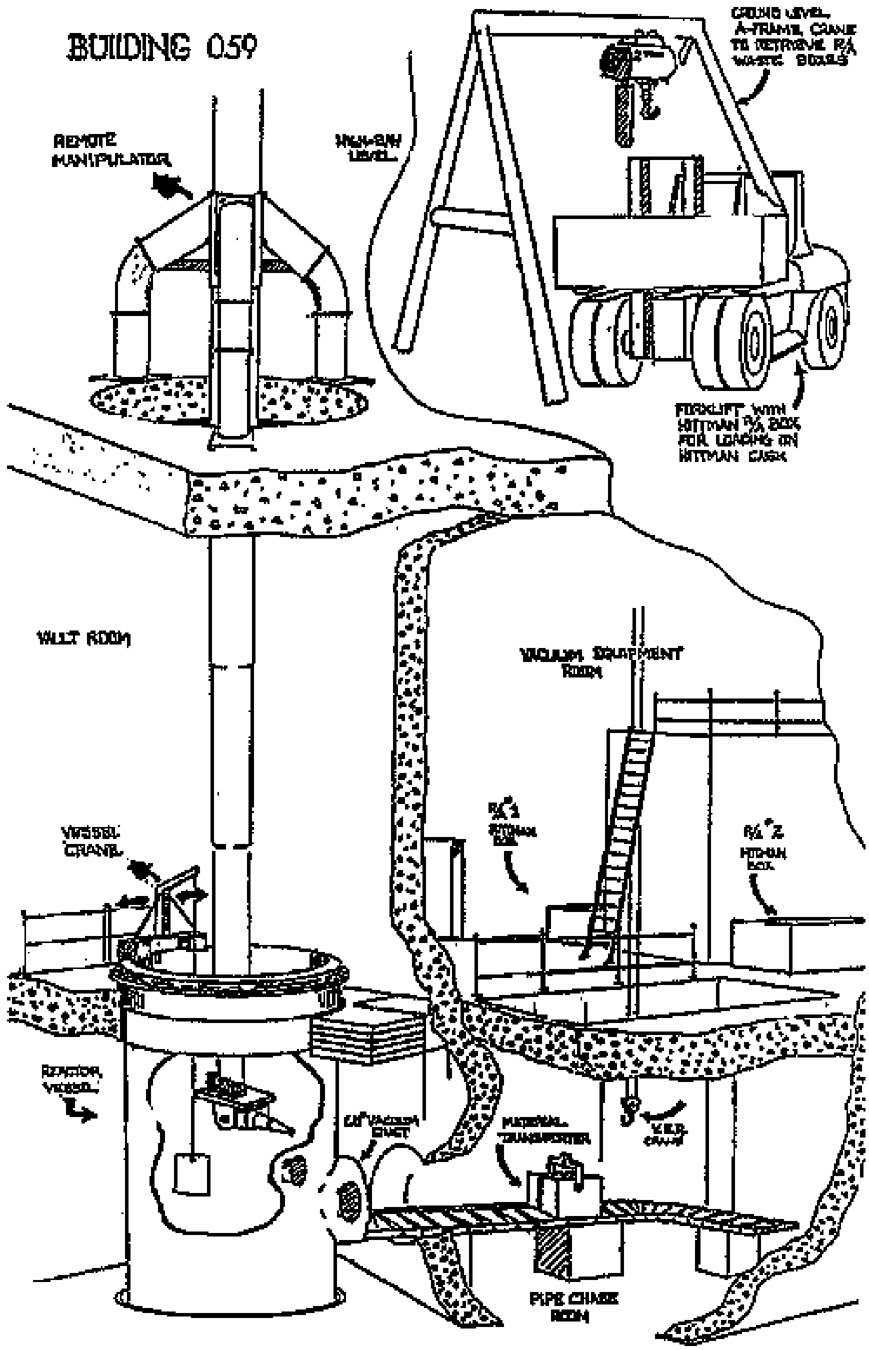


Figure 2.4.2.1 Conceptual Drawing of the Vacuum Vessel Removal Activity

Figure 2.4.2.2 View From Grade Level High Bay. LLTR Structure Removed To Allow Remote Cutting Equipment Access To Test Cell. Notice Containment Tent and Ring Mounted Hoist

Figure 2.4.2.3 Remote Cutting Equipment and Vessel Mockup

Figure 2.4.2.4. Remote Cutting Device on Elevated Stand to Simulate Actual Elevations

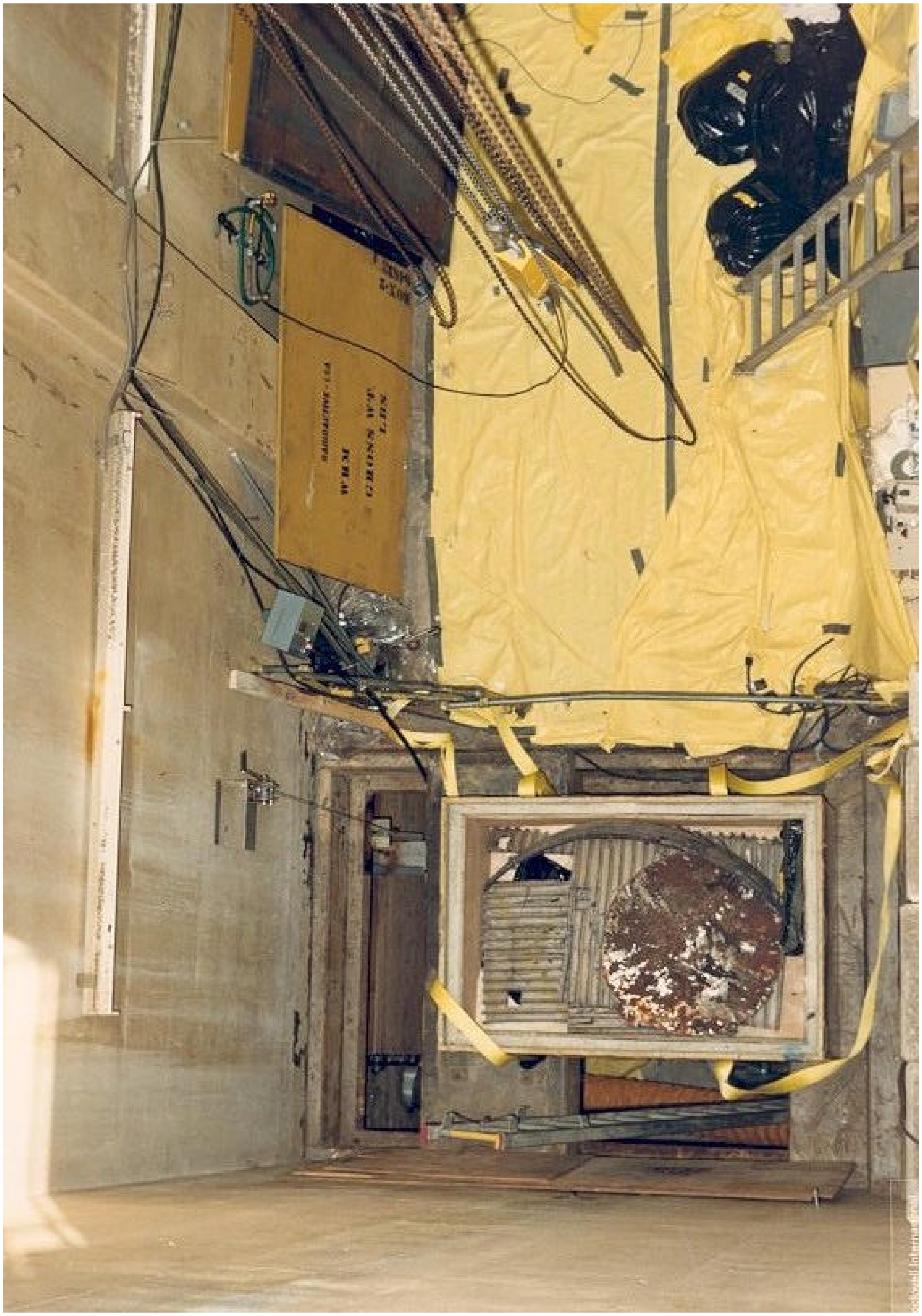


Figure 2.4.2.5. View from Grade Level Looking at Vacuum Vessel Parts Loaded into Shielded Shipping Container. View is of Former Vacuum Equipment Room (Pipe Chase Room is below shipping container)

2.4.3. Concrete Shield Demolition

A previously owned standard commercial backhoe tractor was bought and modified for the concrete shield demolition and removal task. Backhoe arm tooling selected included a hydraulic hammer for breaking up the concrete; a hydraulic shear for cutting the rebar, coolant pipes, and conduits; a hydraulic-powered thumb to assist with rubble pickup and off-loading into the waste transfer box; and a bucket attachment for picking up the rubble. This approach is illustrated in Figure 2.4.3.1. Tractor modifications included rearrangement of the hydraulic-control valving to accommodate the added tooling options and the remote operation planned; removal of the hydraulic control assembly from its normal mounting position on the tractor frame to facilitate remote control station positioning; addition of a larger hydraulic fluid reservoir and increased fluid cooling radiator capacity; replacement of the regular hydraulic fluid with an approved nonhazardous high-temperature mineral oil-based fluid to preclude the generation of mixed hazardous waste in the event of a hydraulic line rupture or fluid spill in the test cell working area.

Two facility locations, one in the test vault and one in the VER, were selected and modified to accommodate the tractor body and backhoe arm mounting structure to allow working access and coverage for the backhoe arm and its tool attachments to perform their functions in the north test cell. Following completion of these modifications and mockup testing, the concrete D&D was initiated and successfully accomplished. The cast-in-place concrete shield, which partially filled the space between the vessel and the cell liner, was removed by breaking up the concrete into manageable chunks and cutting the embedded rebar and conduits into short lengths. Removal of the concrete rubble and waste initially used the same waste transfer system used for the vacuum vessel, and later employed a direct lift method through the high bay floor hatch.

Figures 2.4.3.2.through 2.4.3.5 show elements of the equipment and processes used to complete the shielding concrete removal.

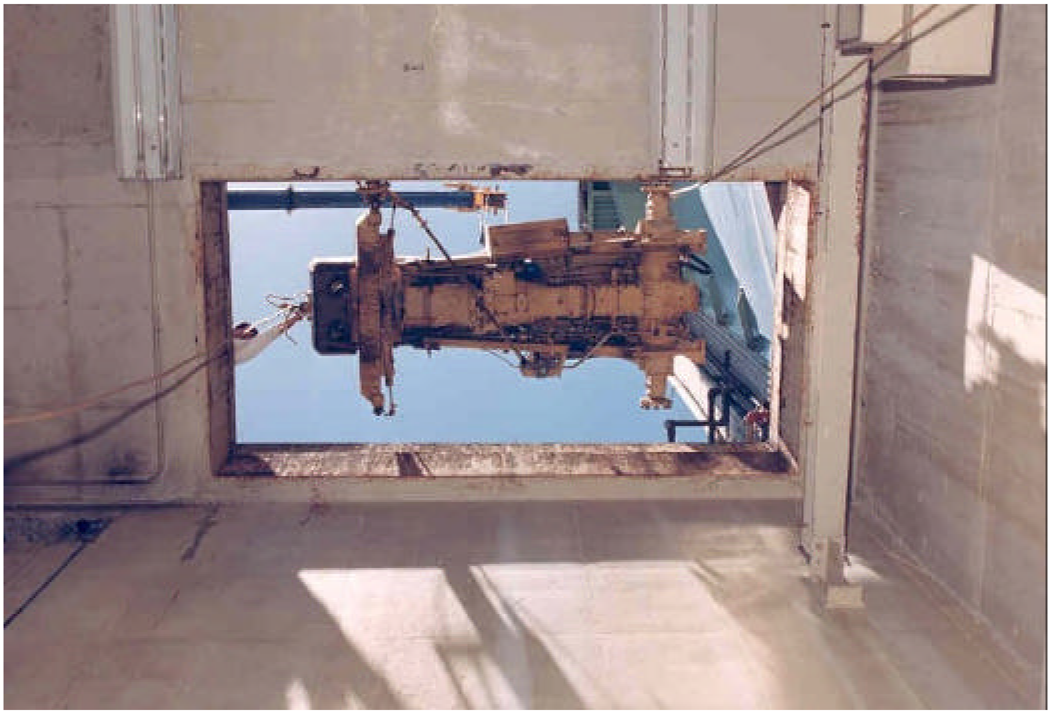


Figure 2.4.3.2 Lowering the Tractor into the Vacuum Equipment Room

Figure 2.4.3.3 Remote Operations Setup in the VER

Figure 2.4.3.4 Concrete Being Removed from the Test Cell Using the Conveyor

Figure 2.4.3.5 North Test Cell Shielding Concrete Removed to the Cell Steel Liner

2.4.4 Test Cell Liner Cutting and Removal

Two special remotely controlled, plasma-arc torch metal-cutting devices were designed and assembled for the test cell lining removal task. These designs also utilized existing nuclear inspection and hot cell experience and technologies. The first device, the wall segmentation device (WSD), was an adjustable, floor-supported, vertical frame with a movable horizontal beam which supported a remotely controlled movable torch-mount assembly for cutting the cell liner walls. The WSD operating in the north test cell is shown in Figure 2.4.4.1. The second device, the floor segmentation device (FSD), used the same plasma-arc torch, mount, and power supply as the WSD; however, it had two-dimensional radial positioning capability rather than the three-dimensional linear positioning of the WSD. A floor-supported guide ring and a cogged radial extension arm provided the torch mount support and positioning structure for the FSD. The FSD is shown in Figure 2.4.4.2. Both devices were designed, fabricated, mockup-tested, and successfully utilized for removal of the vertical and horizontal portions of the test cell liner. These devises were successfully deployed to section the steel liner remotely and protect operating personnel from excess radiation exposure.

Figure 2.4.4.1 North Test Cell Wall Liner Segmenting Device (WSD)

Figure 2.4.4.2 North Test Cell Floor Liner Segmenting Device (FSD)

2.4.5 North Test Cell Summary

Approximately 39 tons of radioactive steel vacuum vessel, coolant piping, conduit, structural supports, and test cell liner; 192 tons of ordinary, borated, and high density reinforced shielding concrete forms and structures; and 24 tons of D&D-generated waste materials were removed from Building 4059 during the Phase II Remediation operations. A total of 158 boxes containing 11,300 cubic feet of packaged LSA waste materials were processed and shipped to the DOE Hanford burial site during this project phase.

2.5 LLTR REMEDIATION AND UPPER BUILDING RELEASE SURVEY

2.5.1 Background

The Large Leak Test Rig (LLTR) sodium system component test system was constructed in the late 1970s and operated through 1982 by the Energy Technology Engineering Center (ETEC). ETEC was a Department of Energy (DOE) laboratory with a charter to perform non-nuclear qualification testing for liquid metal reactor (LMR) program components.

The LLTR was installed and operated in the B/059 vault area above the reactor test cells, with some sodium loop sections above the north test cell and one component, the sodium Reaction Products Tank (RPT), located in the previously unused south reactor test cell. The S8DR reactor vacuum vessel and concrete shield were removed in the test cell remediation program described earlier. This effort resulted in the removal of that portion of the LLTR sodium system that was located above the north reactor test cell (Refer to Figure 2.4.2.2). The earlier demolition operations resulted in some distribution of radioactive dust on the LLTR and other building surfaces. Because of this, the subsequent LLTR demolition activities were controlled activities and all items were required to be decontaminated, surveyed, and released prior to removal from the facility.

2.5.2 Facility Description

The LLTR consisted of two separate, yet interrelated, systems (loops). Those were the water/steam loop and the sodium loop. Both of those loops consisted of piping of various sizes (up to 18”), valves, tanks, instrumentation with associated wiring, trace heaters, piping supports and insulation. The sodium loop, excluding the fill/drain tank, had been previously flushed with solvents to remove residual sodium. However, it was known that the horizontal pipes and piping low points contained residues of solvents and sodium and it was suspected that sodium heels were present at elbows and low points. It was estimated that the lower six feet of the RPT contained sodium-water reaction products but it was later confirmed that the level was much higher and that over 20,000 pounds of sodium remained in the tank.

The water/steam loop, although previously drained, was known to contain residual water in the horizontal pipes and low points so samples were taken and analyzed to confirm that radioactive materials were not present within the system components.

2.5.3 Remediation Activities

The LLTR dismantlement activity was started in June, 1996 and was completed in 2 years. The activities performed for LLTR system dismantlement are described in greater detail in Reference 4. For the purpose of this document the main activities are summarized as follows:

(1) Removal of LLTR components and materials with required size-reduction for either reuse or disposal at an approved waste site

(2) Cleaning of radiologically contaminated internal building surfaces

(3) Removal, packaging and disposal at an approved waste site of radiologically contaminated/activated piping, fixtures and components

(4) Recycling of recoverable scrap, including sodium and sodium oxides, and disposal of hazardous materials and waste

After removal of the LLTR mechanical components, all remaining component and system structural supports were removed, HEPA vacuumed, surveyed to verify that no radiological contamination was present and was disposed of as "clean" trash or recyclable scrap metal. Also, to prepare the facility for the final decontamination and release surveys, the remaining SNAP related components were removed. These components consisted of instrumentation, some small piping and the basement HEPA exhaust system, including the blower and filter plenum. This left the entire facility virtually empty, allowing for the HEPA vacuuming of all interior facility surfaces. HEPA vacuuming was performed from the highest level down. All surfaces, including the high bay ceiling, walls and floor were vacuumed. HEPA vacuuming was also performed on all of the basement surfaces making the facility ready for the Final Release survey. Several inches of steel plate were placed on the floor of the north test cell in order to reduce the radiation levels above the cell allowing for the direct instrument surveys required for free release of the basement. Additionally, a one-inch thick steel cover was installed over both the north and south test cells. This cover further reduced the radiation "shine" from the cells and was used to prevent debris from the facility demolition from falling into the test cells where they could become contaminated and increase the quantity of radiological waste produced during the demolition of the test cells and pipe chase room. Figures 2.5.3.1 through 2.5.3.3 show some of the dismantlement activities.

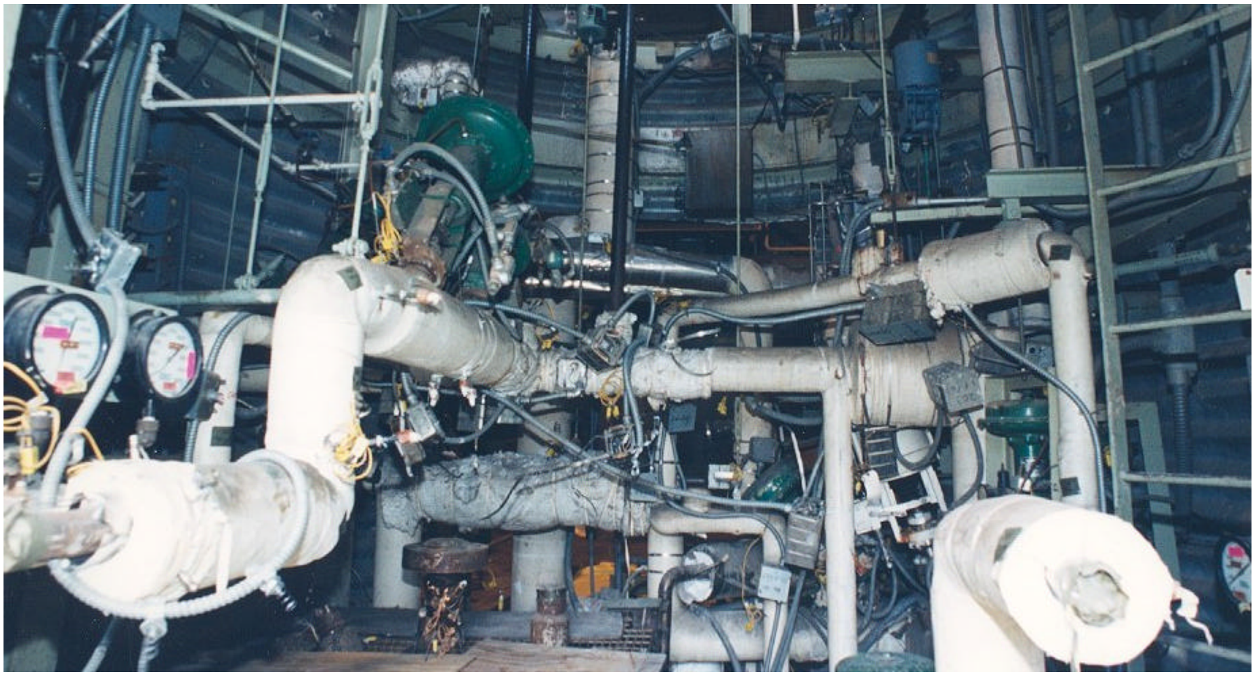


Figure 2.5.3.1 Typical LLTR Test System Configuration Prior to Dismantlement

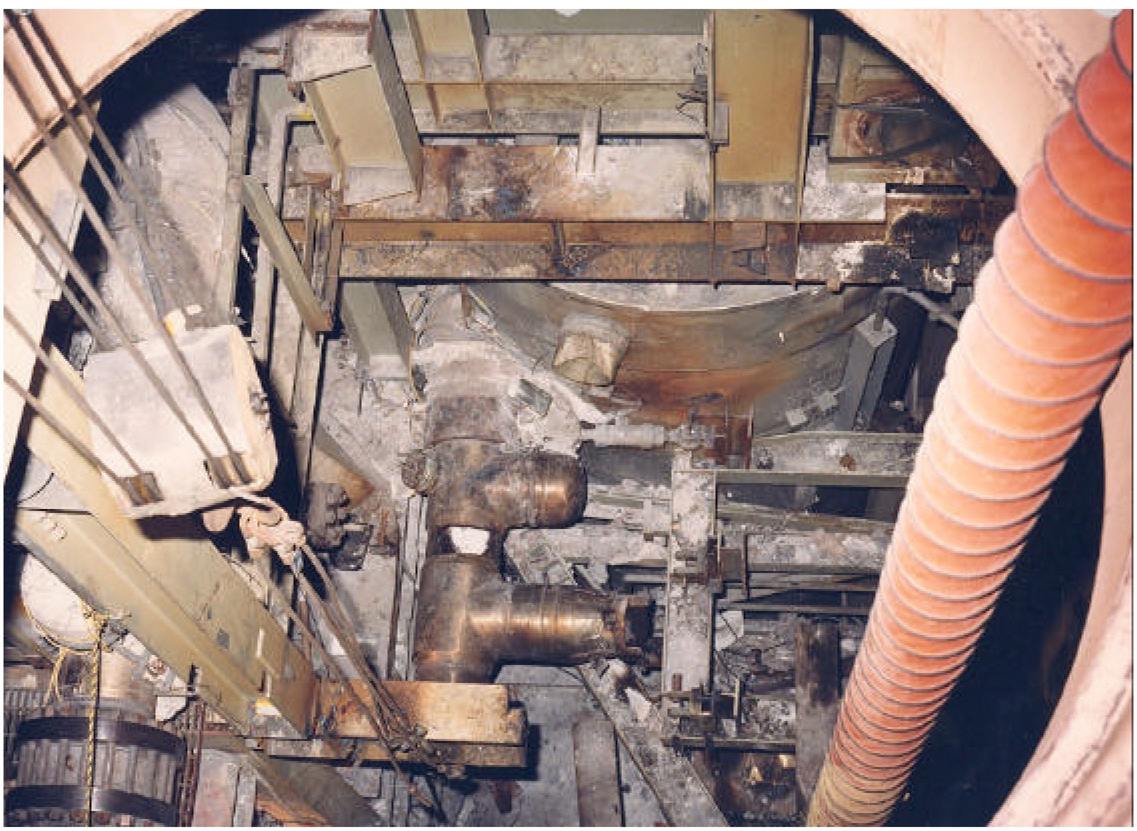


Figure 2.5.3.2 View from High Bay Showing aPortion of the LLTR System Structure Removed

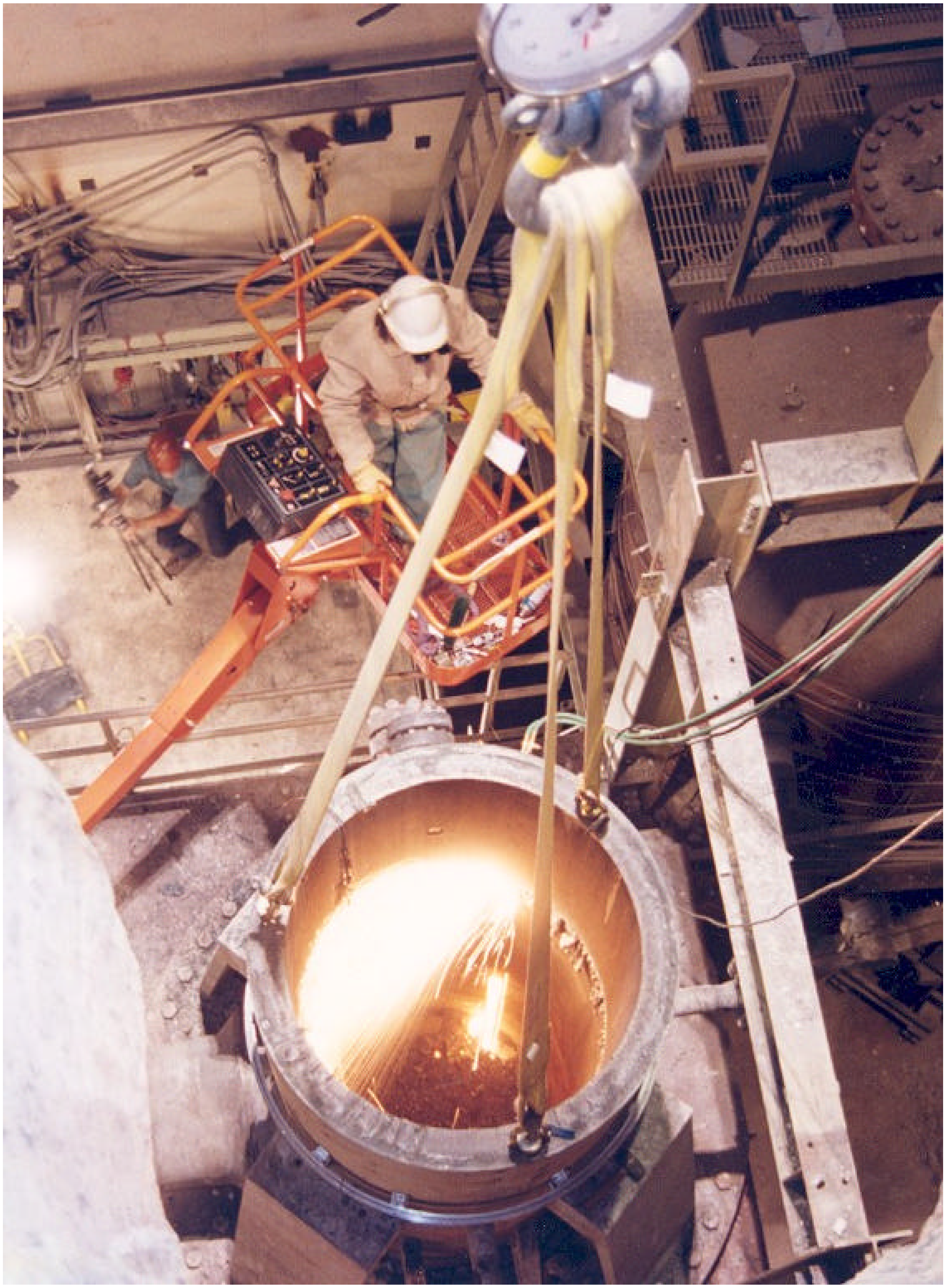


Figure 2.5.3.3 LLTR System Vessel Removal to Allow Radiation Survey of Facility Surfaces

2.5.4 Upper Building Release Survey

At this point in time, the radiation field had been lowered enough by radioactive materials removal to allow core samples to be taken in the north test cell walls and floor. The core data was used to assess how much more material needed to be removed to release the facility. Unfortunately, the activation products were present in unacceptably high levels in the foundation concrete structural members. The facility could not be released by removing further activated structural materials unless an extensive new foundation system were designed and installed to support the upper part of the facility. It had become apparent through trade analyses that the entire facility would have to come down to remove the remaining contaminated materials.

A new approach was formulated to define where activated materials requiring removal began and where materials that could be released ended. Concrete core samples were taken and analyzed and a separation line in the facility was defined. Everything above the line (Phase I) would be released and demolished using conventional methods. The remaining structure below the line would be treated as radiologically contaminated and packaged as LLW (Phase II). The data, analysis and plan supporting this two phased approach were sent to the DOE and to the California Department of Health Services – Radiological Branch (DHS) for review and concurrence. Both agencies formally concurred with the plan.

As part of the release of the Phase I (demolition of the upper, released part of the facility), the LLTR dismantlement was followed by HEPA vacuuming of the entire facility. A final survey for radiological materials was then performed as discussed in Section 2.6 below.

2.5.5 LLTR Waste Generation and Product Recycled

About 700 cubic feet of radioactive waste was generated and shipped for disposal during the LLTR remediation activity. These wastes consisted mainly of insulation and small components that could not be surveyed with the confidence level necessary to allow for release.

25,600 pounds of bulk sodium was transferred to a new owner for use in an industrial process. Secondly, Residual sodium was converted into 39,070 pounds of sodium hydroxide and reused in established industrial processes.

2.6 FINAL FACILITY DEMOLITION AND SITE RELEASE SURVEY

2.6.1 Overview

During the time period the upper part of the facility had been completed and was ready for release, members of a nearby community group expressed concerns regarding the management of radioactive materials at the SSFL. As a result, the normal process for the release for unrestricted use of former facilities involved with radiological materials was augmented by an additional agency review. Building 059 was subjected to a radioactive materials survey by Boeing survey using the Multi Agency Radiation Survey & Site Investigation Manual (MARSSIM) guidance document protocol, a verification survey performed by DHS-RHB, an additional verification survey performed by the independent Oak Ridge Institute of Science and Education (ORISE), and yet another survey performed by a independent contractor to the EPA. Additional core samples were taken for analysis, instrument and smear surveys were repeated, and another report was produced describing the status of the upper building. All reports, including the report prepared by the EPA contractor, concluded the applicable release standard for the upper portion of the facility was met.

During this time period the Governor of California established a directive to the State agency overseeing landfills to stop the acceptance of "Decommissioned Waste." Decommissioned Waste is the term created to describe wastes originating from radiological or former radiological facilities which have contamination below the established release threshold for radioactive materials but above that of background. Under the directive, unlined and Class 3 municipal landfills could no longer accept wastes originating from radiological facilities unless the wastes met background levels of radioactivity. The new restriction resulted in impacts to both cost and schedule.

The demolition of Building 059 was delayed by the completion of the Environmental Assessment by the DOE. Once the EA had been completed, the DOE suspension of demolition activity on Radiation Facilities was lifted and the 059 project could resume. All radiological surveys had been completed and concurrence that the data showed the facility met the cleanliness criteria for unrestricted use was obtained from involved parties. The approval to place the demolition waste at a California landfill was not granted so the waste was packaged and transported to the Nevada Test Site for disposal at a significantly higher cost to the DOE.

With DOE's concurrence, the decision was made to proceed with demolition of the above grade Building 059 structures. Due to the near term onset of the rain season, the entire demolition activity would have to be done in stages. The first stage of demolition would be the low bay portions of the main structure and all support structures and components within the perimeter fence line including underground utilities. The high bay structure would be left in place to protect the activated portions of the basement from rainwater entry during the winter months while planning and preparatory activities for the final phase were completed. This first phase of the demolition of the above grade structures (with the exception of the high bay) took place from May through August, 2003. Before and after photos of the site are shown in Figures 2.6.1.1 and 2.6.1.2. The second photo also shows the set up for loading waste into "SuperSacks" in the foreground. Phase I of the demolition produced in 864 tons of concrete and 210 tons of metal, wood, asphalt and other building debris as well as 6 roll offs of ACM from the low bay roofing materials. Because there was no options for disposal sites within the state, the ACM was shipped to the DOE Hanford LLW burial site (NTS had restrictions on the types of waste they could receive) while the remaining materials were shipped to the LLW site in Nevada (NTS).

Following the above grade structures demolition completion, work began immediately on the detailed planning for completing the removal of all remaining structural materials. The planning included the following main activities:

- Define Site Geology And Excavation Requirements
    - Bore hole drilling and core analysis
    - Excavation design concepts
    - Logistics planning for moving personnel and material
    - Bid process for clean building demolition and site excavation
        - Specification for the excavation of the site
        - Submit required documents for county grading permit
        - OSHA excavation requirements
- Activated Concrete Removal
    - Block cutting and lifting fixture design
    - Specification, bid and award process
    - Lifting plan, crane requirements (separate contract)
    - Concrete block support (scaffolding contract)
    - Contaminated water control/minimization plan
- Site Final Survey And Backfill

The detailed planning started in September of 2003 and culminated with the demolition and excavation contract award in May, 2004. The demolition approach taken was to perform the excavation and simultaneous demolition of the below grade released facility structure using conventional means. The test cells and walls containing the radioactive activation products were clearly identified to the demolition contractor. He knew where to stop the Phase I demolition. The activated concrete (Phase II) was cut into blocks using a variety of concrete cutting techniques and lifted from the area using a large crane. The onsite work was completed by August, 2004 when all contractors had left the site and the final survey of the remaining excavation was started. Separate contracts were awarded for the crane, scaffolding and concrete cutting activities. A registered engineering geologist assisted Boeing during the excavation in an effort to maintain a safe excavation and safe work site. Boeing acted as the general contractor and coordinated the efforts of the 4 separate subcontracts as well as the on site Boeing support personnel. Sections that follow discuss the approaches and issues associated with the primary activities in more detail.

Figure 2.6.1.1 Building 059 Facility Prior to Demolition in 2003

Figure 2.6.1.2 Building 059 Facility After Low Bay Demolition in 2003

2.6.2 Site Geology and Excavation Design

An understanding of what was under and around the site was necessary to plan for the safe removal of the underground structure, to provide documentation for Ventura County to obtain the required grading permit and to supply enough information to the bidders for the demolition and excavation work for a firm fixed price contract. A contractor was selected to assess the site geology by core drilling and testing removed rock at varying depths and to provide a geophysical report documenting the findings. Part of the assessment included reviewing known data and supplementing the background information with specific site detail.

The SSFL site is underlain by Cretaceous-age bedrock of the Chatsworth formation. The formation is described as light gray to light brown, hard coherent arkosic sandstone, in thick strata separated by thin partings of siltstone. The strength of the rock varies significantly with location. The region characteristics include bedding strikes about N50E dipping about 30 to 35 degrees to the northwest.

One of the initially problematic site issues for the new excavation leading to the final demolition of Building 059 was a bedding strike of very loose shale and siltstone tilted at a 35 degree angle toward the north side of the building. The south side of the site was the most accessible to build ramps and stage equipment, but because the shale bed was subject to failure, engineering assessments recommended not using heavy equipment on the south side. Extensive shoring was prohibitively expensive and shallow sloping left equipment too far away from the facility structure. The crane to be used to lift the 20,000 pound blocks would have to be located elsewhere. The selected site design concept was to locate the crane west of the building at the 40 foot below grade elevation. This location and elevation allowed the crane to be within 95 feet of the farthest “pick point” of any block and to be able to lift any block to the staging area above without exceeding the lift parameters for the 180 ton capacity crane. The area chosen for the access ramp to move men and heavy equipment into the work area was on the north side. The selected arrangement maximized the excavation of the relatively soft shale material (as opposed to the relatively hard sandstone) during the crane access and north access ramp installation. Using a crane to remove the blocks eased the movement of supplies, light equipment, vessels containing cutting water, etc. to be placed on pallets and ‘flown’ in and out of the excavation using the crane. The excavation final design is reflected in the post excavation photographs in Figure 2.6.2.1 and 2.6.2.2

Evidence of the type of geology at the Building 059 site can be seen in construction photos taken during the west addition to the original facility in 1964. In Figure 2.6.2.3, rock bolts installed to prevent wedge failure in the original excavation can be seen near the right side of the photograph. The photos show the 1964 addition was constructed with nearly vertical excavation walls as seen in Figure 2.6.2.4.

A specification package for the released building demolition and the site excavation was prepared. The specification included applicable OSHA requirements for deep excavations where personnel would be working. The county of Ventura also has local jurisdiction over construction or demolition activities and requires demolition permit as well as a grading permit prior to activity commencement. A significant effort was required to prepare submittals for county review and eventual approval. One of the challenging issues for the participating bidders was estimating the ease of rock removal and also the amount and type of shoring required for a safe worksite for personnel entry.

Figure 2.6.1.1 SGPTF Excavation Looking West

Figure 2.6.1.2 SGPTF Excavation Looking East after Upper Building Demolition

Figure 2.6.2.3 West Addition Excavation in 1964 Showing Rock Bolts in Shale Bed at Upper Right

Figure 2.6.2.4 West Addition Excavation in 1964 Showing Vertical Walls of Excavation

2.6.3 Activated Concrete Removal

Prior to setting up the site for safe removal of the activated concrete, the upper released portion of the facility was demolished and hauled away to interim storage. The high bay and concrete structure underneath were demolished down to the line indicating where the activated structural materials requiring special handing were located. The debris from the released part of the building was stored nearby until being eventually shipped to a Class I (hazardous waste) disposal site as “Decommissioned Waste.” Figures 2.6.3.1 through 2.6.3.4 show the demolition process which necessarily included construction of the excavation as demolition proceeded downward.

Removal of the activated concrete structure required extensive analysis and planning. Because the structural materials were activated to levels requiring disposal at a radioactive disposal site, disposal fees are charged on volume of material and not weight of material. Trade offs of various demolition methods verses resulting volume changes and contamination risks were analyzed. It was concluded that wet concrete cutting provided the most cost effective and least risk of environmental contamination. A cutting plan was designed to minimize the square feet of cutting required to keep concrete contractor costs minimized. At the same time the blocks were sized to optimize shipment weight to keep the total number of waste shipments to a minimum. This plan also provided a uniform standard for the competitive bid process for the concrete cutting contractors. Plans were made for three types of block lifts; 1) the blocks from the ceiling of the PCR, 2) wall blocks, and 3) blocks from the floors sitting on bedrock. Figures 2.6.3.5 through 2.6.3.14 show the work during various stages of the activated concrete removal.

In addition to the cutting plan, lifting fixtures were designed, fabricated and proof tested. The lifting fixtures utilized hole positions core drilled into the blocks. The positions were calculated and then marked on the block to enable the load to be stable when it was lifted from the structure. As mentioned previously, excavation design constraints dictated the capacity and type of crane required to lift the blocks from the structure.

One of the main concerns for the concrete cutting operation was the control and minimization of contaminated water generation. The concrete cutting process uses water to cool the cutting area and aid the process. Because the water was contaminated, it needed to be contained and a process needed to be in place to minimize the total volume. Spilled or released cutting fluids could jeopardize a project goal of meeting the radiological release limits once the blocks were removed. The subject of cutting water control was stressed in the specification for the contract. The selected contractor used collection systems to contain the water within the facility and also recycled the collected water back to the equipment. These actions resulted in less than a 5,000 gallon inventory of water to be processed by the end of the work.

Radiological contamination at the work site was further controlled by continual clean up operations within the controlled areas and monitoring at exit points. Plastic was used to cover areas around the work and under the block transfer route as can be seen in Figure 2.6.3.9. The concrete blocks were vacuumed or rinsed prior to removal from the excavation to the staging area above.

Figure 2.6.3.1 High Bay Demolition Complete

Figure 2.6.3.2 Demolition of High Bay Floor Complete

Figure 2.6.3.3 Construction of North Ramp Access

Figure 2.6.3.4 Demolition of Released Portion Nearly Completed
(Note Weak Shale Area at Upper Center and Hard Rock at Upper Left)

Figure 2.6.3.5 Released Concrete Demolition Completed. Site Prep for Activated Concrete

Figure 2.6.3.6 5-ft Diameter Blade Saw Being Used in Wall

Figure 2.6.3.7 The First Concrete Block is Lifted from the Structure

Figure 2.6.3.8 PCR Scaffolding to Support Floor Blocks During Cutting

Figure 2.6.3.9 Blocks Were Lifted to Staging Area

Figure 2.6.3.10 Blocks Were Surveyed and Wrapped for Shipment

Figure 2.6.3.11 The Last Floor Block Being Lifted from the Site

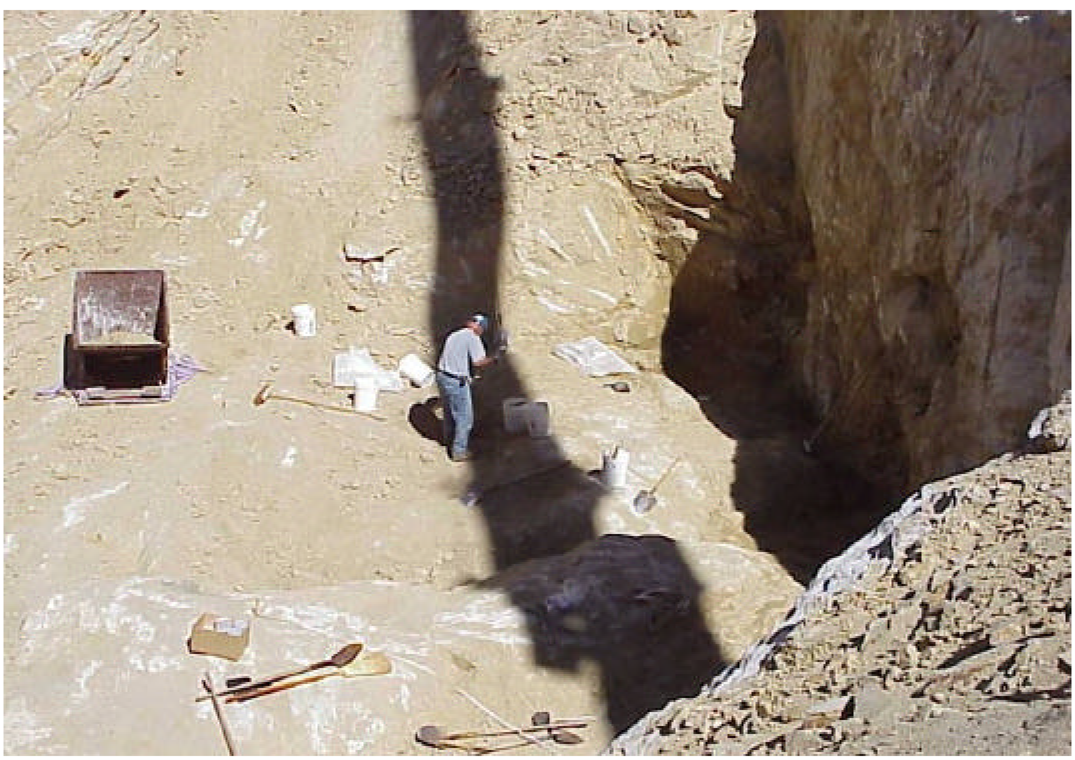


Figure 2.6.3.12 Small Amount of Contaminated Soil Being Removed

Figure 2.6.3.13 Sampling for Contamination

Figure 2.6.3.14 The Clean Excavation

2.6.4 Site Final Survey and Excavation Backfill

Surveys of contractor equipment were performed and support contractors had moved offsite by the end of September, 2004. Contamination surveys, small cleanup actions and company owned equipment disposition were completed. The internal MARRSIM compliant final survey of the site has been completed and a report will be issued. Verification surveys were completed by the DHS and ORISE prior to initiation of backfill. The excavation was then backfilled to 90% compaction or better. Figures 2.6.4.1 and 2.6.4.2.show the backfill and compaction and the compaction verification process respectively. Figure 2.6.4.3 shows an aerial view when the excavation was about 85% completed.

Figure 2.6.4.1 Building 059 Excavation Backfill Process

Figure 2.6.4.2 90% Plus Compaction Verification

Figure 2.6.4.3 Building 059 Excavation 85% Completed

3.0 GOVERNING REGULATIONS, DOCUMENTS, AND PROCEDURES

The SGPTF decontamination and demolition program has been regulated externally by various government agency requirements, and internally by Rocketdyne Safety, Health, and Environmental Affairs requirements and procedures. In addition, program directions were defined by program management plans, and specific procedures were prepared and approved prior to performing individual D&D activities. Those approvals included reviews by health and safety personnel, quality assurance personnel, and a licensed structural engineer as appropriate. The characterization and off-site shipment of generated wastes were subject to requirements and acceptance criteria specific to the individual disposal sites.

Day-to-day activities performed as part of the facility decontamination and dismantlement were documented in dated operational log books entitled "Building 059 D&D Log Book." Information recorded in those log books also included the identification of work crews and other relevant operational details. Quality Assurance and Environmental Surveillance Records are maintained on file. Extensive sets of photographs were taken to document the decontamination and dismantlement activities. Monthly progress reports were prepared and submitted to the DOE as part of the program documentation requirements, and constitute part of the work activity record.

4.0 PERSONNEL PROTECTION

Personnel safety is a central element of Rocketdyne's D&D practices. The Boeing Canoga Park System of Procedures (SOP), and its predecessor, the Rocketdyne System of Procedures, include safety, health, and environmental guidelines intended to protect workers in the field, and those guidelines are incorporated in the Detailed Working Procedures and other instructions for job performance. In addition, field personnel are required to complete training courses specific to operations where safety hazards potentially exist. For D&D work, including the Building 059 project, radiation protection is a key area where specific controls, procedures, and monitoring programs have been implemented. The objective is to minimize any adverse effects to the health and safety of workers, the public, and the environment caused by operations that involve radioactive materials.

4.1 ALARA

Rocketdyne's policy for all activities associated with work areas where radioactive materials or radiation fields are present, including radioactive materials handling, is to maintain personnel radiation exposures As Low As Reasonably Achievable (ALARA). This policy is implemented site-wide through a Rocketdyne ALARA program, whose general objective is to minimize radiation exposures received both by individuals and by groups. Its mission is the prevention of exposures above regulatory limits, the mitigation of unnecessary exposures, and the optimized reduction of exposures deemed necessary for the performance of work. The program includes planning, reviewing, training, monitoring, surveillance, and the deliberate use of safeguards and administrative controls to achieve ALARA goals. By achieving these goals and using ALARA methods in effluent controls, effects on the public and the environment are negligible. Implementation of this program is the responsibility of Rocketdyne's Safety, Health, and Environmental Affairs (SHEA) organization.

4.2 ALARA IMPLEMENTATION

Radiation level, surface contamination, and airborne radioactivity concentration surveys were performed in all areas of the SGPTF prior to, during, and following work activities. These surveys were performed by trained, experienced Radiation Safety technicians and engineers who were independent of the operations groups. They specified allowable work times, personnel monitoring devices (pocket dosimeters, film badges, thermoluminescent dosimeters [TLDs], and finger rings as appropriate), and the requirements for specialized protective equipment (protective clothing and respiratory devices). Radiation Safety personnel reviewed engineering designs and operating procedures to assure control of radiological hazards, and had the responsibility and authority to halt potentially unsafe operations.

Entry was controlled into facility areas where the radiation level or airborne radioactivity was likely to exceed acceptable levels for continuous work. Maximum personnel radiation dose limits were based on the SOP Planning Guide limits of 1.0 rem per calendar quarter and 2.0 rem per year (whole-body dose). For comparison, federal regulatory limits are 5 rem per year. Individual doses were measured to ensure compliance, and group doses were monitored based on the individual dose results.

5.0 WASTE GENERATION SUMMARY

The total waste generated from the life of the decontamination and demolition of the SGPTF beginning with the Pipe Chase Room Remediation is summarized in Table 5-1. This encompasses the entire above-ground structure of the buildings, the below-grade structures, the outside yard areas (support structures, asphalt and soil), and all equipment associated with the facility operation.

Table 5-1
Waste Generation Summary for the SGPTF

Activity	LLW Waste		Decommissioning Waste (tons)
	(volume – ft3)	(weight – tons)	
PCR Remediation	4,652	~ 100.0	
North Test Cell Remediation	11,300	322.2	
LLTR Dismantlement	705	7.8	
Above Grade Site Demolition	54,284	1,084.0	
Below Grade Facility Demolition and Site Restoration	16,800	912.0	3,814.4
Program Total	**87,741**	**2,426.0**	**3,814.4**

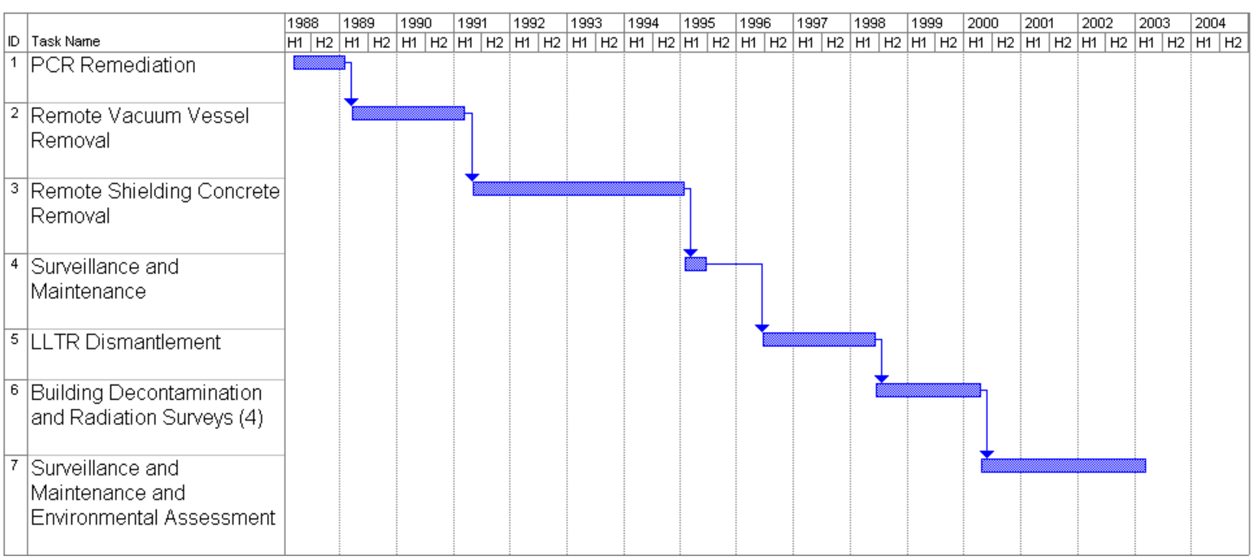
6.0 PROGRAM COST AND SCHEDULE SUMMARY

Costs associated with the Building 059 Remediation Program starting with the Pipe Chase Room remediation are summarized below.

Cost Summary for the SGPTF Decommissioning

ACTIVITY	TOTAL ACTIVITY DOLLARS (000's)	WASTE SHIPPING PORTION OF COSTS (000's)
PCR Remediation	758.0	92.2
Remote Vacuum Vessel Removal	6,139.5	775.5
Remote Shielding Concrete Removal	1,822.8	451.2
LLTR Dismantlement	245.1	8.1
Building Decontamination and Radiation Survey	598.5	
3 years Surveillance and Maintenance and Ground Water Management	518.2	
Above Grade Site Demolition	706.8	380.0
Final Facility Demolition and Site Restoration	3,139.4	480.0
Program Total	**13,928.3**	**2,187.0**

SGPTF Overall Schedule



7.0 LESSONS LEARNED

The decontamination and dismantlement of the SGPTF included the application of several innovative approaches to D&D, and some post-task insight on task performance. This section annotates the key lessons learned from the program, which may contribute to planning and execution of D&D projects for similar facilities at other sites.

A general observation is that an effective D&D project is based on a well-conceived plan, the availability of an experienced D&D staff, a good knowledge of the facility and its history, and an optimum combination of proven technology, innovative techniques, and specialized experts for unique or high-risk tasks. Personnel safety, ALARA conformance, contamination control, and waste minimization are primary considerations in the planning and execution of all D&D projects. Specific lessons learned are discussed below:

Adaptation and use of proven, off-the-shelf equipment for remote metal cutting and concrete demolition was successful and cost effective.

The decision, early in the planning stages of this project, to maximize use of both on-site D&D experience and knowledge about existing equipment, such as the remote handling hardware manufactured by PaR, led to adapting this equipment for the remote cutting of the vacuum vessel. Previous hands-on use of this equipment for ISI led experienced personnel to focus promptly on issues related to engineering modifications (both equipment and facility), deployment logistics, and operational adaptations.

Similarly, the availability of a suitable commercial backhoe tractor led to a novel adaptation of this machinery for accessing and size reducing the concrete shield remotely. Using an equipment design that has already been used for many millions of hours in the field and has been modified to be reliable and overcome issues related to wear and environmental field conditions is an advantage. Designing and building one time use specialized robotic equipment usually has a learning curve and significant downtime associated with making the equipment work reliably.

In addition, using a commercially available cleanable cartridge prefilter system is an effective method to significantly reduce radioactive waste volumes. During D&D of Building 059, many of the demolition tasks, particularly plasma cutting and concrete size reduction, generated large quantities of fine particulate. Without prefilters to collect this radioactive material, the HEPA filters would plug quickly. Early in the program, disposable prefilter systems were designed and used to adequately protect the HEPAs during the program, but resulted in a large waste volume. Material costs and increased labor for handling, changeouts, and packaging waste increased overall program costs significantly. Investigations into this problem eventually led to acquisition of a recleanable cartridge prefilter system. This system was tested under plasma smoke collection conditions and performed well Using a commercially available system is a very effective method to protect HEPA filters as well as reduce the secondary waste stream significantly.

Use of the philosophy of adapting *proven* equipment is recommended for future applications involving remote cutting of activated steel and remote size reduction of activated concrete elsewhere in the DOE complex.

Trade studies, mockup testing and operator training were useful in achieving predictable and reliable performance.

The trade studies leading to selection of the tractor equipment and tooling for concrete D&D showed the availability and limitations of such equipment, and the engineering solutions needed to overcome the limitations and adapt the equipment and tooling to this project. Mockup tests verified the performance of the equipment and tooling and provided a means for concurrent training of operators before deploying them in the facility environment.

Sustained use of certain equipment parts in confined spaces for heavy-duty operations over relatively long periods nevertheless leads to breakdowns and subsequent repairs, as was the case, for example, with the jack-hammering of the high-density-concrete shield. Systematic attention to preventive maintenance, critical spare parts inventory and early repair/replacement of damaged equipment is recommended whenever such long-term operations are forecast.

8.0 REFERENCES

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